

RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY
AND ALLIED SCIENCES

EDITOR
LEON J. MENVILLE, M.D.

ASSOCIATE EDITOR
HOWARD P. DOUB, M.D.

S. M. S. I



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22 YEARS

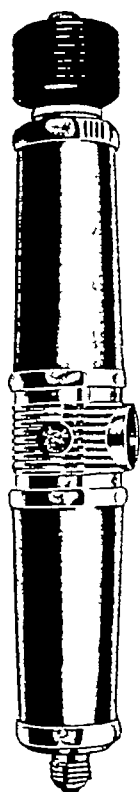
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NO 1

ADMINISTRATION OF ARTIFICIAL PNEUMOTHORAX UNDER FLUOROSCOPIC GUIDANCE

By JOHN BLADY, M D , and LOUIS COHEN, M D , *Philadelphia*

Departments of Roentgenology and of Diseases of Chest, Temple University Medical School
and Eagleville Sanatorium

THE following presentation is a preliminary report of special artificial pneumothorax work being carried out for the past several months at Temple University Hospital, namely, the administration of artificial pneumothorax under direct fluoroscopic guidance. For many years large numbers of pneumothorax cases have been receiving refills in this hospital, with the development of a large pneumothorax clinic. Such a clinic is absolutely essential for the follow-up treatment of patients discharged from hospitals and sanatoria. The routine procedure in the artificial pneumothorax clinic has been to fluoroscope the patient in the upright position immediately before the treatment. The fluoroscopic examination includes a direct fluoroscopic tracing of the entire chest, with particular reference to the shape and position of the collapsed lung. The patient is then sent to the operating room, placed in the usual pneumothorax position, lying on the "good" side, and given four or five hundred cubic centimeters of nitrogen in the usual way. Encountering difficulty in the administration of gas to a formerly easy case whose fluoroscopic tracing showed a well collapsed lung suggested to one of us (J B) the possibility of giving the treatment directly under fluoroscopic guidance. This treatment was successfully performed with the aid of the fluoroscope without the slightest difficulty. Since then a regular

special clinic has been held every week for the treatment of difficult cases under fluoroscopic guidance, with gratifying results. This clinic has proven of inestimable value to us, and failure to find any reference to this type of work in the literature has prompted us to describe our procedure.

After the first few refills were performed by the fluoroscopic method it became clear to us that the universally routine method of fluoroscopic control of pneumothorax cases suffers frequently from a very glaring error. The usual method employed in most clinics is to fluoroscope the patient in the upright position just before the treatment and then to administer the gas with the patient lying on a stretcher. Often a marked change in the fluoroscopic appearance of the collapsed lung occurs when the patient is changed from the upright position to the lateral decubitus pneumothorax position. To determine just what does happen we have routinely fluoroscoped all our patients in the upright and in their exact pneumothorax position with the horizontal ray, and have found very definite differences which will be described in the accompanying diagrams. It is very easy to understand why occasional difficulty in giving a refill occurs when one has accurate evidence of the difference in the two fluoroscopic tracings of the same case. It required merely a fluoroscopic study of a few cases with the horizontal ray to

demonstrate to us that this method is indispensable. It gives us a much more accurate picture of the position and shape of

so easy and simple as to cause us to feel that pneumothorax treatment in a particular case should never have to be discon-

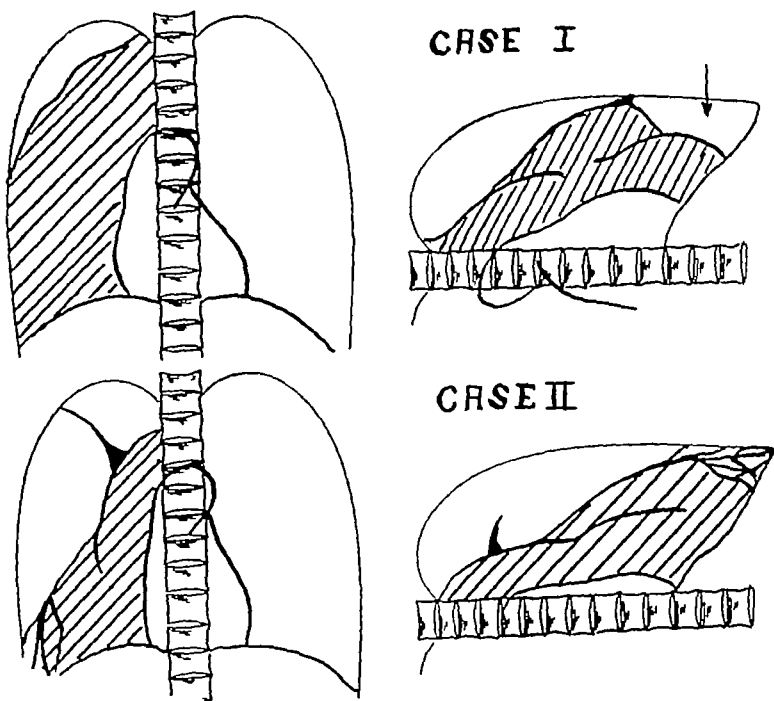


Fig 1 Case I The diagram in the upright position is a ventral projection and shows an apical collapse. The lateral decubitus position dorsal projection reveals a partial collapse of all portions of the right lung except that part prevented from collapsing by an adhesion. Blood-spitting frequently followed administration of treatment through the usual axillary site. Under fluoroscopic guidance the pneumothorax needle was introduced at the position indicated by the arrow and the refill treatment was successfully given without any blood-spitting sequelae.

Case II The tracing made in the upright position is a ventral projection while the horizontal is a dorsal projection. The network of adhesions at the costophrenic angle prevents a greater collapse and may be the cause of difficulty in administering the refill treatment if the needle is introduced at the right costophrenic angle.

the collapsed lung at the time of the treatment, thus minimizing difficulty and, in some cases, danger of lung injury.

Fluoroscopic pneumothorax administration, we believe, is indicated in any case in which the operator has difficulty in doing a refill. The treatment is given with ease and accuracy and the fluoroscopist can indicate to the operator the exact interspace to use, can watch the needle enter the pleural cavity, and see the lung collapse as though he were looking directly into the pleural cavity. There is no harm to the patient and the technic is

continued solely because of difficulty of administration of the gas. In the comparatively short time during which we have been availing ourselves of this additional help in pneumothorax technic, it has already given us a feeling of assurance about difficult cases which we never had before. Now we know that when a patient in the regular clinic gives us trouble, the treatment can usually be continued without difficulty under fluoroscopic guidance. This method may also later prove to be helpful in initial cases and in trying to find loculated fluid in the pleural cavity for

patient on his side, on the other hand, an adhesion which prevented the mid-portion of the lung from collapsing was demon-

apical collapse, with a small amount of fluid overlying the lung, which appears to be adherent to the thoracic cage. This ap-

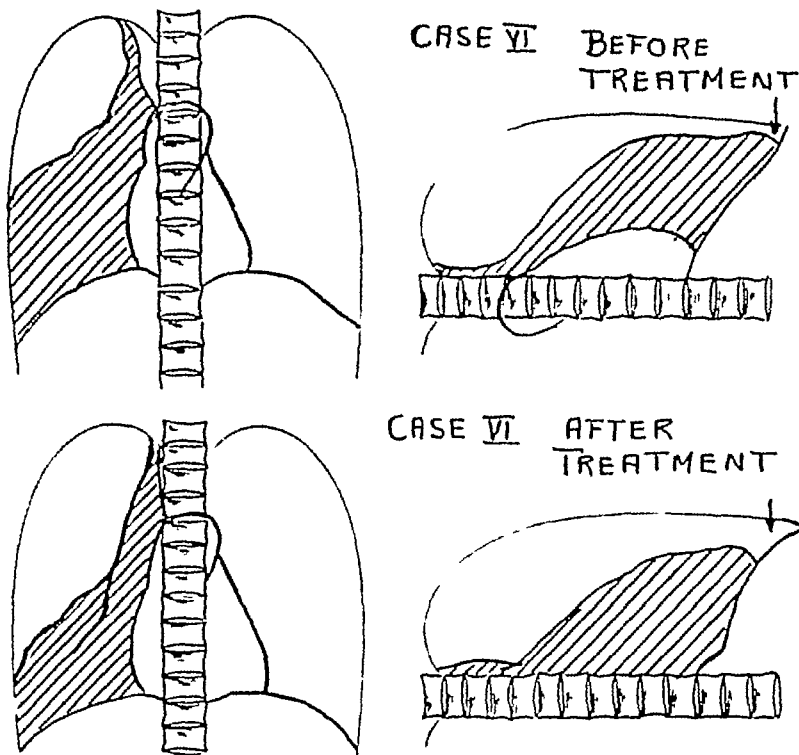


Fig 4 Case VI The two upright diagrams are ventral projections and the other two are dorsal projections. Because on several occasions difficulty was encountered in finding a pneumothorax pocket, fluoroscopic guidance was used and enabled us to find a very small pocket of air at the costophrenic angle into which the needle could be safely introduced. Note change in position of lung when patient is studied in the lateral decubitus position.

strated. Above and below this adhesion, however, a fairly large pneumothorax was apparent. On several occasions treatments administered through the usual axillary site caused blood-spitting. Since then the treatments have been successfully given at the costophrenic angle (at position of arrow, ninth interspace) with fluoroscopic guidance.

Case II, L E. This case demonstrates lower lobe adhesions. No appreciable change was noted in the appearance of the collapsed lung when the patient lay on the unaffected side, the adhesions prevented a greater collapse. Inserting the pneumothorax needle in this region might lead to difficulty in administering the treatment.

Case III, P A. The upright roentgenogram and fluoroscopic diagram reveal an

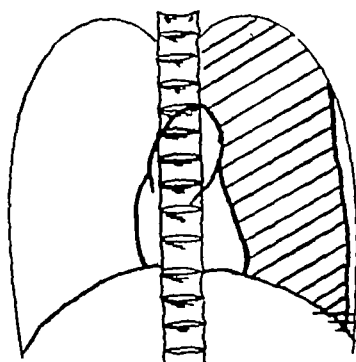
appearance is suggestive of an obliterative pneumothorax. Fluoroscopic study with the patient in the lateral decubitus position showed the lung to be well collapsed and not adherent to the chest wall. In this position the fluid shifted to the mediastinal aspect of the left apex.

Case IV, D C. A case of hydropneumothorax showing the importance of studying the patient while he is lying on the unaffected side. The shifting of the fluid reveals a large pneumothorax and a good collapse of the lung.

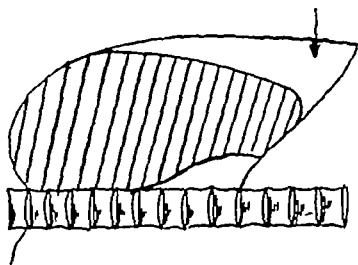
Case V, J B, 21 years of age. The lung is adherent at the left apex. At the left base the lung is sufficiently collapsed to visualize a small pneumothorax pocket, this is better demonstrated when the patient is examined in lateral decubitus. Un-

illuminated with a red light, thus providing sufficient illumination for preparing the skin and for the operator to observe the

A consideration of vital importance is the exposure of the operator's unprotected hand to the primary beam. We have made



CASE V BEFORE TREATMENT



CASE V AFTER TREATMENT

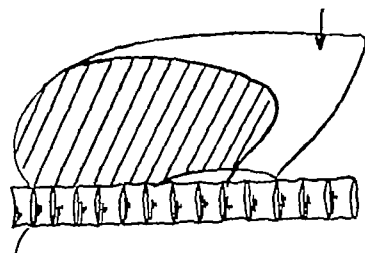
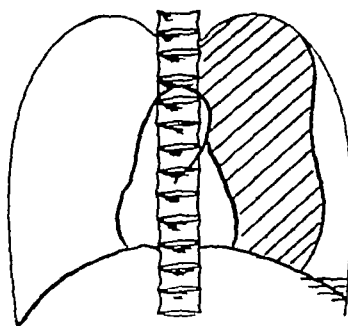


Fig 3 Case V Diagrams of the chest showing the position of the left lung before and after treatment. The upright and horizontal position diagrams are ventral projections. Arrow indicates position of pneumothorax needle during treatment.

manometric oscillations and the amount of fluid in the bottles without interfering with fluoroscopic visualization. Our present source of light is a small portable flashlight fitted with a red filter.

The most suitable place for the insertion of the needle is located fluoroscopically. The skin is prepared with iodine and two applications of alcohol and the patient is draped. Local anesthesia is employed in every case. Under fluoroscopic guidance the needle is introduced into the pleural space and its position is always carefully observed, especially in those cases in which the needle is introduced at the costophrenic angle or into a very small pneumothorax pocket. While the air is being injected into the pleural cavity the collapse of the lung and change in the position of the lung, diaphragm, heart, and mediastinum are carefully observed.

It is a practice to use as small an aperture as possible and to keep the operator's hand out of the beam at all costs. With this in mind we have devised a lead shield which is readily attached to the operator's arm and always offers adequate protection to the hand in case it may be exposed momentarily to the primary beam.

REPORT OF CASES

The following selected cases illustrate a few common differences between the fluoroscopic tracings made with the patient in the upright position and in lateral decubitus. In these cases the fluoroscopic pneumothorax technic proved to be of great value.

Case I, E. T. Examination of the chest with the patient upright revealed a minimal collapse of the right apex. With the

fluoroscopic examination of the patient in the lateral decubitus position is essential for a better understanding of the actual difficulties that one may encounter when giving a pneumothorax refill and for localization of the most suitable space for the insertion of the pneumothorax needle. This has led us to the following conclusions:

1 The fluoroscopic and roentgenographic appearances which have led to the characterization "selective pneumothorax" are often completely absent when the patient assumes a horizontal position. Present-day conceptions of so-called "selective pneumothorax" must be modified.

2 Any case which presents difficulty during administration of the refill should

have the advantage of fluoroscopic guidance before further treatment is discontinued. All guess-work in the difficult cases has been replaced by direct observation and accurate guidance. The feeling of relief and assurance which has come to us through this procedure is hard to express on the written page.

3 The carrying out of the pneumothorax treatment under fluoroscopic guidance should be reserved for difficult cases only. In these cases it is an indispensable adjunct to our armamentarium in collapse therapy.

Further observations that may follow a larger experience with this work will be reported at a later date.

der fluoroscopic guidance the pneumothorax needle was introduced at the costophrenic angle and a successful col-

easily introduced under fluoroscopic guidance

Altogether, we have studied 80 pneumo-

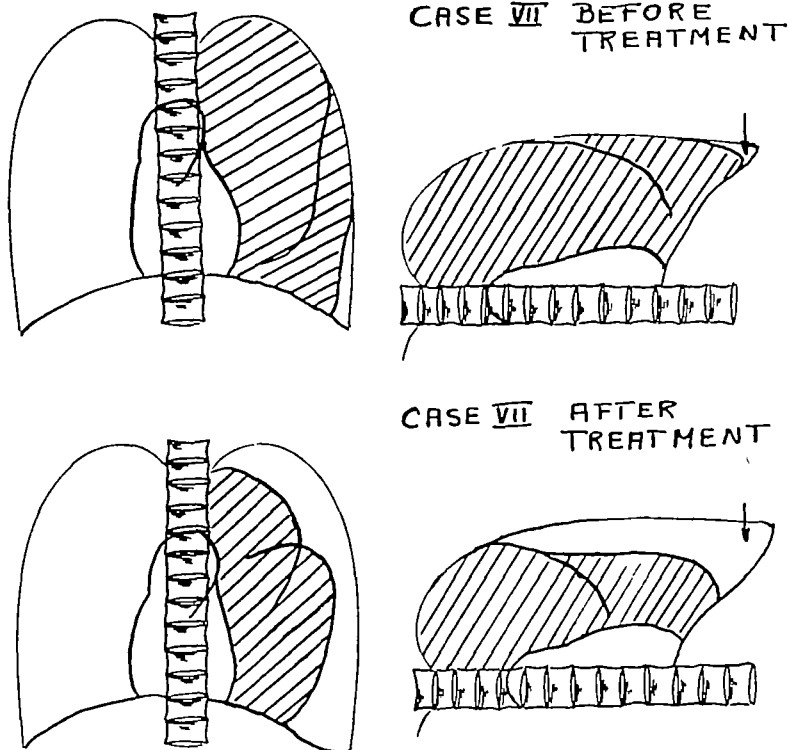


Fig 5 Case VII These are all ventral projections The left lung is practically entirely expanded except for the small pneumothorax pocket at the left costophrenic angle Under fluoroscopic guidance the pneumothorax needle was safely introduced into this space and a very satisfactory collapse was obtained as is shown by the two lower diagrams

lapse of the lung was obtained without encountering any difficulty whatever

Case VI, I G The upper two diagrams show the appearance of the right chest before treatment Because of difficulty in the administration of the treatment in the right axilla, the pneumothorax needle was inserted at the costophrenic angle, even though the pneumothorax space was minimal The position of the needle was carefully watched and at no time was there any danger of injury either to the lung or to the diaphragm

The lower two diagrams show the resulting pneumothorax

Case VII, E M. This patient, as in Case 6, illustrates the costophrenic pocket of gas into which the pneumothorax needle was

thorax patients for comparative data on the position of the thoracic viscera in the upright and in the lateral decubitus positions To date, we have given 40 pneumothorax treatments under fluoroscopic guidance to 20 individual pneumothorax patients We have attempted the administration of initial pneumothoraces with this procedure but as yet a sufficient number have not been performed to properly evaluate its usefulness

SUMMARY

We have studied 80 individual pneumothorax cases to determine the difference in the appearance of the chest in the upright and in the lateral decubitus positions The

III "Precancerous Dermatoses"—

- (A) Xeroderma pigmentosum (frequently)
- (B) Senile keratoses and keratoses which are the sequelæ of radiotherapy, arsenic, and tar (occasionally)
Basal-cell epithelioma never develops in true cases of Bowen's and Paget's diseases

HISTOLOGY AND EMBRYOLOGY

The complexity and divergent views regarding the embryology of the epidermis and cutis, the status of the so-called basement membrane, and the relationship between elastic tissue, connective tissue, and *Gitterfasern* is reviewed by Lynch (43) and also Pinkus (68). The hair follicle results from an invagination of the epidermis, and the outer root sheath of the follicle is composed of basal cells, as is also the outer layer of the sweat ducts and sebaceous glands. My observations, which support Peck's views that both basal and dendritic cells are melanoblasts and that dendritic cells are probably modified basal cells, admit that the question of pigment-formation is not yet settled (51). Pigment-containing cells are normally seen in the outer root sheath only to the depth of the rete ridges, although the cells of the hair matrix and bulb give a positive dopa reaction (67). In my experience, the basal cells of the epidermis have prickles or intercellular bridges comparable to the prickle-cell layer. I likewise am in accord with the views of Broders (10) and Hansemann regarding the anaplasia and dedifferentiation of individual cells. A basal tumor cell that retains its ability to form pigment is more differentiated and, therefore, less malignant than a basal tumor cell which multiplies without the formation of pigment. Only the basal cells and a varying number of layers of prickle cells above them are potentially neoplastic, as cells that have undergone even partial keratinization are no longer capable of reproduction.

This study is based on twelve years' clinical and histopathologic observations of cu-

taneous neoplasms. The tissue for the most part has been fixed in formalin or absolute alcohol and stained routinely with hematoxylin and eosin, van Gieson's stain, elastin H, or Unna's acid orcein and polychrome methylene blue for elastic fibers, and in many cases with silver nitrate stain for melanin and Maersch's modification of the Bielschowsky stain for *Gitterfasern*. In some cases Unna's neutral orcein, Mason's trichrome stain, and similar connective tissue stains, various silver stains for nerve fibers, and frozen sections for "dopa" were studied.

BENIGN FORMS OF BASAL-CELL EPITHELIOMA

Epithelioma Adenoides Cysticum, Syringoma, and Cylindroma—The typical cases of epithelioma adenoides cysticum, syringoma, and cylindroma may be differentiated clinically by their different size and situation of the lesions (76). The first may have a hereditary basis, the others apparently have not. In many cases, however, clinical and histologic features of two or more of these conditions are seen in the same individual (36, 53 and 82) or even in the same specimen for biopsy (35, 75 and 80). Whereas, cylindroma is usually confined to the scalp (71), I have seen several cases in which a solitary lesion occurred on an arm or leg, which histologically presented the rather characteristic hyaline changes within and about the nests of tumor cells. None of these conditions clinically suggest a malignant process.

Ingels' patient (Fig 1-A), whom I was able to observe clinically and pathologically for a period of years, presented both clinical and histopathologic features of epithelioma adenoides cysticum, syringoma, and adenoma sebaceum (Pringle). The case was also unusual clinically in that lesions first appeared when the patient was 36 years of age, rather than in childhood. The generalized distribution and small size of the individual lesions, together with the involvement of the dorsum of the phalangeal joints, suggested the clinical diagnosis of pityriasis rubra pilaris. Wax recon-

HISTOGENESIS OF BASAL-CELL EPITHELIOMA¹

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WISH to discuss the histogenesis of benign and malignant forms of basal-cell epithelioma of the skin proper, admitting the fallacy of attempting to solve the pathogenesis of a given tumor from study of the morphologic changes only. The observation of many types of epithelioma in various stages of development, compared with the clinical findings and subsequent course of the type of neoplasm in question, permits, I believe, the drawing of conclusions regarding their histogenesis. I favor Krompecher's concept of the basal-cell origin of these tumors, but I shall attempt, nevertheless, to clarify divergent points of view as expressed recently by Haythorne, who supports Mallory's (46 and 47) concept of a hair-matrix origin for *Basalzellenkrebs* (Krompecher), and by Glasunow, who expressed the belief in their benign and dysontogenetic nature, and would call these tumors "facial fissure cancrroids" or "haut carcinoid."

Confusion has arisen, I believe, through failure to distinguish between the benign and malignant forms of basal-cell epitheliomas, to study lesions in their earliest stages, and to prove by serial section or various methods of reconstruction their origin primarily from hair follicle, sweat gland, or sebaceous gland. The term "epithelioma" includes both benign and malignant cutaneous neoplasms, because a sharp distinction between the two is not always possible (36). The term "carcinoma" is restricted to rare cases of adenocarcinomas of sweat glands and sebaceous glands, and to metastatic lesions in the skin from carcinoma elsewhere in the body. Although I have read well over a thousand articles on epithelioma, I shall refer only to the more recent and pertinent literature. The reader is also referred to various chapters in Jadassohn's *Handbuch* (2, 8, 27, 54, and 73), especially, and to the new editions of Orms-

by's and Sutton's textbooks on dermatology and those on dermatohistopathology by Freiboes, Gans, and McCarthy.

To simplify the discussion, a working classification of basal-cell epithelioma is given, recognizing the fact that the so-called epithelial nevi (referring especially to verruca senilis), nevus pigmentosus, and melano-epithelioma may not properly belong in this group, and that transitions between benign and malignant forms of epithelioma frequently occur. I shall discuss histopathologic changes and embryologic and etiologic factors in the various subgroups.

CLASSIFICATION OF EPITHELIOMA PRESUMABLY OF BASAL-CELL ORIGIN

I Benign —

- (A) Epithelioma adenoides cysticum (Brooke), including tricho-epithelioma (Jarish) and adenoma sebaceum (Pringle)
- (B) Cylindroma (nevus epithelioma cylindromatosus—Gans, endothelioma capitis—Spiegler)
- (C) Syringoma (syringocystadenoma)
- (D) Epithelial nevi (Jadassohn and Gans)
 - 1 Verruca senilis, including dermatosis papulosa nigra
 - 2 Sweat gland and sebaceous gland nevi of various types
- (E) Nevus pigmentosus

II Malignant —

- (A) Basal-cell epithelioma (Krompecher's *Basalzellenkrebs*)
 - 1 Superficial epitheliomatosis (erythematoid benign epithelioma—Little)
- (B) Basal-squamous-cell epithelioma
- (C) Melano-epithelioma arising from basal or dendritic cells or both, including melanotic whitlow and so-called lentigo maligna

¹ Submitted for publication April 23 1935

strands to normal sweat glands, probably because the cells of the sweat glands, *per se*, are too differentiated as a rule to give rise to

hand, and where such glands normally do not occur

It becomes evident that even in the case

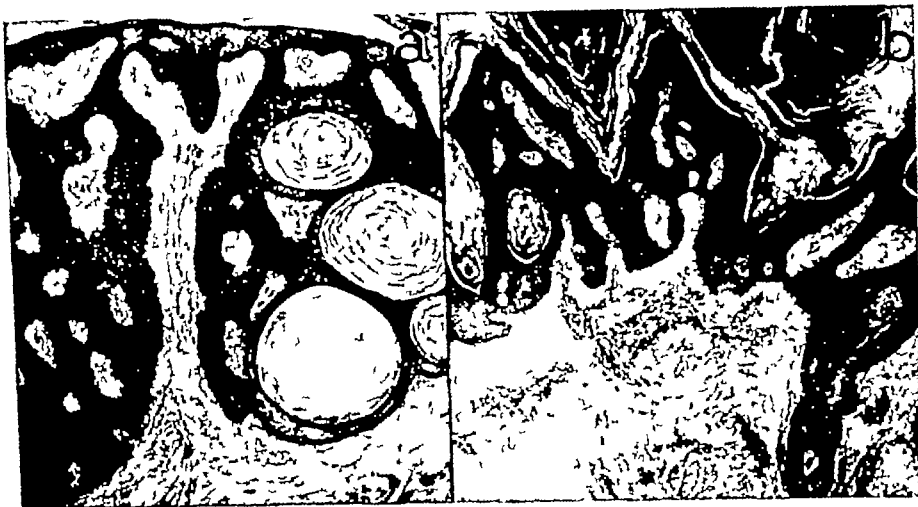


Fig 2 (A) Verruca senilis of forehead Solid type with cysts and strands simulating tricho-epithelioma Marked deposit of melanin pigment in basal cells also some in chromatophores in cutis, (B) verruca senilis near ear—verrucous type Note acanthosis and hyperkeratosis, as well as pigmented basal cells and apparent involvement of hair follicle (silver nitrate and hematoxylin)

revert to a basal-cell tumor Definite connection with normal sweat glands has not been proved in any case of epithelioma adenoides cysticum Weidman (83) emphasized that one cannot classify precisely each benign cutaneous epithelioma either as a tumor or sweat duct or hair follicle, or as a tumor of the superficial epidermis, because all three can be derived from a common embryonal structure, namely, the skin plate of Remak, which is at first not a sweat duct, epidermis, or hair follicle If the skin plate has fully differentiated, then one sees, as in Stilhans' case, a sweat gland in one place, a hair follicle in another, and a Krompecher epithelioma in another Kyrle (39) would attribute syringoma to aberrant apocrine glands, a view which I have been unable to substantiate in seven cases which I have studied

I wish to point out that even true metaplasia may occur in the cells of the epidermis that have begun to differentiate toward sweat ducts This was evidenced in a case, reported by Walther and myself, in which metaplasia toward mucinous glands was seen in a verrucous lesion of the palm of the

of epithelioma adenoides cysticum (tricho-epithelioma), origin is not solely from the walls or matrix cells of a hair follicle All these tumors may be regarded as benign basal-cell growths, although some cases of syringoma (82) and cylindroma may be regarded as hamartoma in the sense of Albrecht, *ie*, a tumor which is formed from misplaced embryonic cells I do not believe that any of these tumors are potentially malignant except that any epithelial proliferation, when subjected to trauma, irritation, or inadequate removal, may undergo malignant change

Verruca Senilis—Verruca senilis has been designated by Becker as a basal-cell growth He apparently regarded as unimportant the definite phenomena of keratinization and cornified cysts, which are present, and which as a rule do not connect with either hair follicles or sebaceous glands Freudenthal, Freudenthal and Spitzer, and I (58) have emphasized the occasional histologic resemblance of verruca senilis to tricho-epithelioma, in certain areas the growth may be chiefly basal-cell in character, and the formation of pigment usually

struction of serial sections from a portion of the nevoid plaque on the back, and of a lesion on the dorsum of the hand, revealed

Society, in October, 1934 (*Arch Dermat and Syph*, May, 1935, 31, 738), which included specimens for biopsy of the early

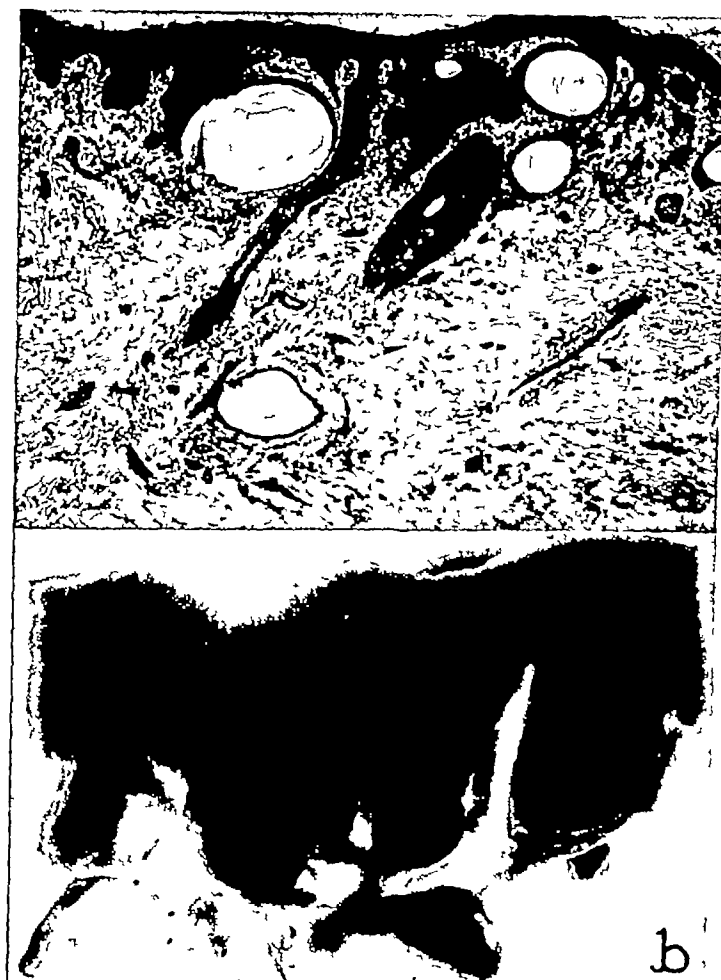


Fig 1 Epithelioma adenoides cysticum with features of syringoma (Ingels) (A) Multiple points of origin of epithelial strands and cysts from epidermis, hair follicle and atypical sweat ducts with comma like tail (B) wax reconstruction of serial sections showing interrelation between epidermis cysts ducts and hair follicles (the bulbous areas represent cysts of various origin)

that the origin of the epithelial strands and cysts was not only from the hair-matrix cells and basal cells of the outer root sheath of the hair follicle, but also from the basal cells of the epidermis and the more superficial portions of the sweat ducts (Fig 1-B)

After further observation of the patient at the meeting of the Chicago Dermatological

lesions on the trunk and thigh, I am convinced that the changes start intra-epidermally, some of the cell nests, strands, and cysts developing into rudimentary hair follicles and others into strands which resemble sweat ducts, occasionally, an epithelial strand showed abortive attempts to form sebaceous cells. It was impossible to trace a direct connection of the sweat-duct-like

strands to normal sweat glands, probably because the cells of the sweat glands, *per se*, are too differentiated as a rule to give rise to

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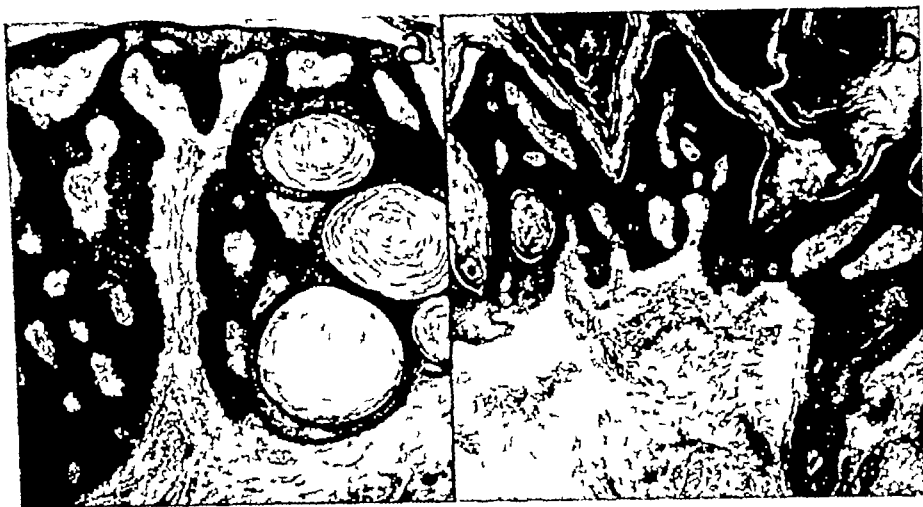


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is marked. Prickle cells are also present in these strands of epithelial cells (Fig 2-A). In the verrucous and hyperkeratotic forms of the disease (58), and in contradistinction to Becker's statements (4), definite acanthosis (hyperplasia of prickle cells) is very obvious, as may be seen in Figure 2-B. In all forms of verruca senilis, the cysts represent invagination of the epidermis, and are composed of stratum corneum, this is the result of a relatively normal and regular cycle of keratinization (34). Because of this, I would prefer to group verruca senilis with delayed epithelial nevi. Several authors, Eller and Anderson, and Becker (5), have referred to benign not nevoid melanoepithelioma of Bloch (7) and have ignored the fact that Bloch's cases were submitted for publication simultaneously with those of Freudenthal, and probably without knowledge of Freudenthal's concept of differentiation of verruca senilis and keratoma senile. Judging from Bloch's description and illustrations, both Dorfelf and I (17) believe that Bloch's first case fulfills the histologic requirements of a pigmented intra-epidermal epithelioma of Jadassohn, with both basal-cell and squamous-cell growths *in situ*, whereas, his second case fulfills all the requirements of a verruca senilis, as does Becker's Figure 21 of his Case 7, in a recent article in the *American Journal of Cancer* (3), and also Figure 47 of Eller and Anderson, and probably Haythorne's Figures 18 and 19. It is this pedunculated elevated type of verruca senilis which may be confused clinically with a verrucous pigmented nevus, and which, because of the excessive pigment formation that gives it a black appearance, may be considered a true melanoma, and therefore be excised. Occasional instances in which verruca senilis has undergone malignant change, usually basal-cell in character, have been reported (17 and 69). Eller and Ryan reported a questionable case of a basal-cell epithelioma on a seborrheic keratosis. I believe that photomicrographs of this case (Figs 10 to 13 in their report) show a typical picture of the solid type of verruca senilis, with benign proliferation of

basal cells. I have seen a few cases of verruca senilis which have shown basal-cell or even squamous-cell malignant change, but only as the result of repeated trauma and irritation, or inadequate removal. I agree with Freudenthal that verruca senilis is a benign process which rarely reveals either clinical or pathologic evidence of malignant change.

Nevus Pigmentosus—If one accepts Peck's opinion that both basal cells and dendritic cells of the epidermis are true melanoblasts, then one has support for Unna's concept of the epithelial origin of pigmented nevi. Becker (6) has recently summarized the concept that pigmented nevi are Schwannoma, on the basis of Masson's concept (48, 49, and 50) of the neurogenic character of moles. Laidlaw pointed out the necessity of comparing the pigmented nevi of human beings to amphibian or reptilian tactile spots to explain the complex and confusing picture of moles which affect human beings. I have seen a fair percentage of nevi in which the so-called "lames foliaces," which resembled tactile corpuscles, were present. Masson's "celles claires" appear to be modified dendritic cells. From experience in studying *Gitterfasern* (lattice fibers or reticulum) in various dermatoses, and as a result of an intensive study of a case of ganglioneuroma (60), I believe that it often is very difficult to distinguish terminal nerve fibrils from connective tissue and *Gitterfasern*, by differential staining only. Broders and Fletcher have commented on Masson's views, and have said "It seems reasonable to assume that since the nervous system and the epidermis develop from the ectoderm, and since moles are of epidermal origin, that their spheroidal cells which we believe to be in an undifferentiated or embryonic state are atavistic to the extent that they are capable of differentiating into nervous tissue, and therefore in such a light may be considered of a neuro-epithelial nature."

As a bridge or gap between benign and malignant basal-cell neoplasms of the skin, Nomland's case, which histologically showed malignant basal-cell epithelioma

that clinically resembled benign pigmented basal-cell nevi, is a good example In this cheek of a man aged 32 years, and which had been diagnosed clinically as a nevus

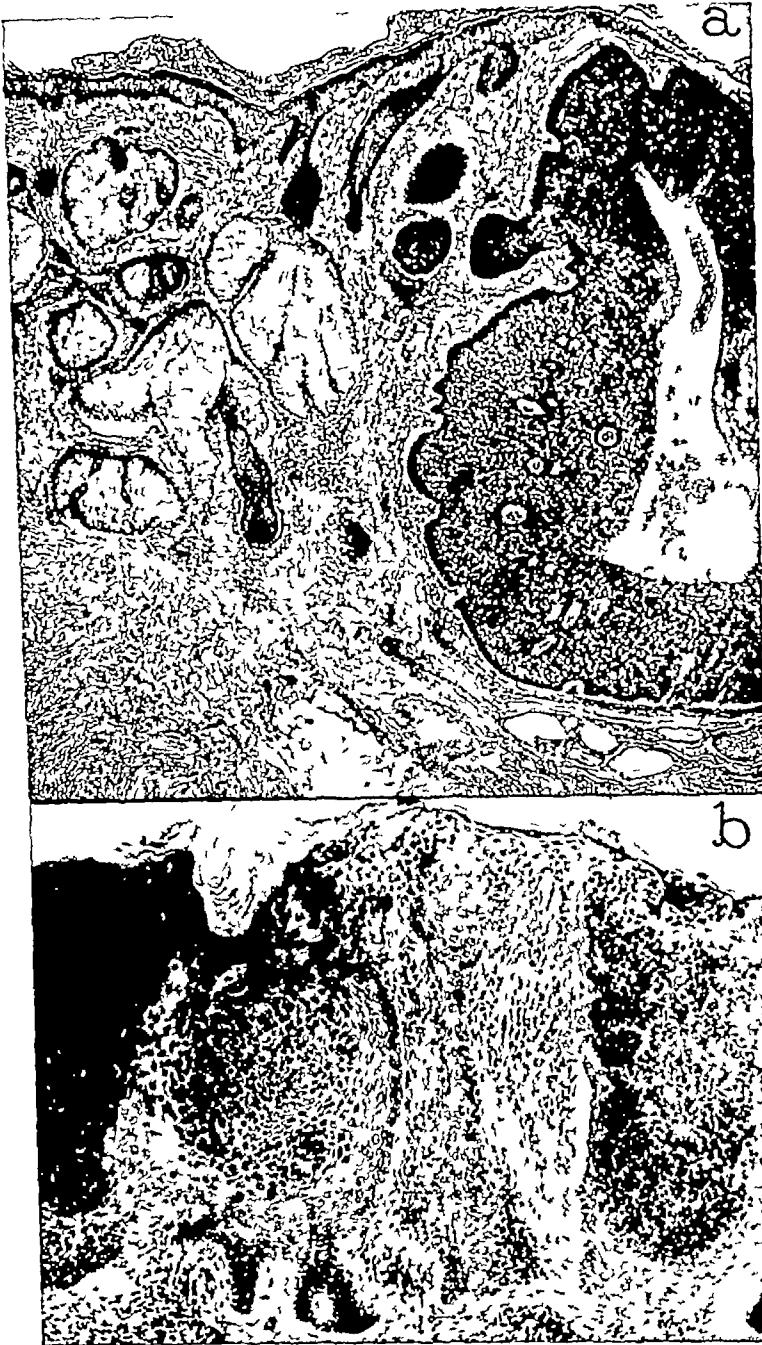


Fig 3 (A) Nevus sebaceus plus a large basal-cell tumor whose connection with the basal cells of the epidermis could be traced but not to hair follicles, to the dilated sweat glands beneath same, or to the sebaceous nevus, (B) intra-epidermal epithelioma (Jadassohn), showing basal-cell epithelioma arising from basal cells of epidermis and growing upward instead of downward, also area of squamous-cell epithelioma *in situ*

connection, see Figure 3-A of a lesion, which sebaceous The histopathologic picture at had been present for twelve years on the the left is that of a nevus sebaceous There

are early proliferative changes in the hair follicles, and at the right there is a tumor mass, which was diagnosed as basal-cell epithelioma, and which was composed of basal cells that could be traced in serial sections to the basal cells of the epidermis but not to either the sebaceous nevus or hair follicle or to the dilated sweat glands lying beneath the tumor mass. The columnar arrangement of the outer layer of cells, the cystic center, and the extravasation of erythrocytes suggested the diagnosis of cylindroma, but without corroborative evidence of hyaline or other changes. (See also cases of Jadassohn (36) and his Figure 5, and Szodoray in which there was a closer relation between nevus sebaceous and basal-cell epithelioma.) The epithelioma which occasionally develops in sebaceous cysts may be basal cell in character (15).

The ability of patients to present multiplicity in types of lesions is also exemplified by Jadassohn's case, in which a patient had psoriasis of the hand, which was treated with roentgen rays. A Bowen-like roentgen epithelioma developed subsequently in one area of the hand, and a low grade squamous-cell epithelioma developed in another area of the same hand. This was associated with an adenoid epithelioma (70), which possibly belonged to the benign sweat gland group. The intra-epidermal epithelioma of Jadassohn (Fig 3-B), which I believe belongs properly to a subdivision of superficial epitheliomatosis, is an example of both basal-cell and squamous-cell growths, which occur in the same lesion but remain *in situ* and, therefore, are relatively benign in nature (13).

MALIGNANT FORMS OF BASAL-CELL EPITHELIOMA

Basalzellenkrebs (Krompecher)—It has been repeatedly confirmed that ordinary basal-cell epithelioma (Krompecher's *Basalzellenkrebs*) has a predilection for certain regions on the face, namely, the forehead, nose, and inner aspects of the cheeks (30 and 61), which also are frequently the sites of the benign epithelioma which was men-

tioned previously. McDonagh called attention to the fact that many mammals, especially deer, have specialized hairs in the orbital facial fold, and explained basal-cell epithelioma on the basis of the lack of need of things that are present in the lower animals, and on the basis of hereditary cell rests. Glasunow expressed the opinion that basal-cell epithelioma on the face commenced in and about the lines of fusion of the embryonic facial processes. Paljtschewsky emphasized the fact that basal-cell growth appear in areas, which are well supplied with sebaceous glands, and often arise from comedones or nevi. Mallory, speaking of basal-cell epithelioma said "The cells which arise from a hair matrix and form the hair and its sheath do not differentiate, except to a slight degree, in the way that the cells of the epidermis do. The hair is composed of cells which develop large numbers of delicate fibrils. These fibrils bind the cells closely together. The cells of the sheath on the other hand undergo cornification to a slight extent. Rarely there is a hint of the formation of intercellular bridges and small epithelial pearls are occasionally present." Haythorne believed that special technical methods support the view that so-called basal-cell carcinomas of the skin are really hair-matrix tumors, and that they are associated with changes in the hair follicles and less differentiated portions of the sebaceous glands. The more exact diagnosis would be "hair-matrix carcinomas." He admitted, however, that complete differentiation of hair-matrix tumors and well differentiated hair formation are indeed rare. Kyrle (38) said that the basal-cell layer of the skin has two tasks to fulfill: (1) to differentiate into pavement epithelium, and (2) to act as a matrix for post-fetal formation of sebaceous glands without formation of squamous cells. When tumors, which arise from the basal-cell layer, grow, as in the latter instance, a basal-cell rather than a squamous-cell epithelioma is formed. In connection with Hanseemann's theory of anaplasia, Broders (10) said "Basal-cell epitheliomas control themselves by producing cells simi-

lar to the normal basal cells of the skin " Weidman's concept of various types of tumors, which develop from the embryonic skin plate, has been mentioned previously Fischer-Wasels has recently presented evidence correlating the Conheim hypothesis of embryonic development with Virchow's irritation theory of the cause of epithelioma.

With the multiplicity of etiologic factors which have been cited previously, it is no wonder that there is still controversy regarding the origin of basal-cell epithelioma, especially of the face, which is the most common situation for this lesion. If the tumor is large and there is apparently a connection with the epidermis, one cannot be sure, from morphologic studies, whether the tumor has originated in the basal-cell layer or is merely a secondary union of an embryonic rest. Thus all combinations of various lesions may be seen, and one sees the ability of basal-cell growths to imitate sweat glands, sebaceous glands, or even hair follicles, without demonstrable proof, in serial sections or wax reconstruction, or origin from any of them. Kyrle justly emphasizes the fact that benign basal-cell growths which may arise from hair follicles (epithelioma adenoides cysticum, trichoepithelioma), are not to be confused with basal-cell carcinoma. The basal cells of the former are smaller in size, more fully differentiated, and show fewer mitotic figures than those of basal-cell epithelioma (carcinoma). I cannot agree with Haythorne, who, on the basis of tinctorial changes and differences in size and character of the cell, regards the junction of basal-cell tumors with the epidermis as false union, as he illustrates, for instance, in Figure 3 of his article. One of the features of malignant basal-cell epithelioma is its propensity for basophilic staining, and the larger and more imperfect forms of individual tumor cells, as compared with normal basal cells, which still retain many of the features of the basal cells of the epidermis, and often the ability to form pigment. The fact that a great many basal-cell epitheliomas are pigmented does not indicate hair-matrix origin any more than it indicates origin from the

epidermis, because melanoblasts of both basal and dendritic cells are to be found in both situations. The outlining of basal-cell tumors (81) by a band of *Gitterfasern* (lattice fibers), denies, I believe, the importance of affinity for silver stains as supporting a hair-matrix origin. My experience confirms that of Way, regarding the value of the Maersch-Bielschowsky stain in differentiation of basal-cell, squamous-cell, and melanotic neoplasms by the arrangement of the lattice fibers. Haythorne refers to the longitudinal fibers, which were described by Mallory, as possibly identical with Herxheimer's spirals, the latter were seen both in the epidermis and hair follicle (45).

It has been my experience that the greatest majority of basal-cell epitheliomas of the face show multiple points of origin from the basal cells of the epidermis.

Basal-squamous-cell Epithelioma—Of considerable significance regarding the basal cell origin of epithelioma, I believe, is the fact which first was brought out most clearly by Darier and Ferrand, and later by myself (55), and by Juon, and by many others, that transitions between basal-cell and squamous-cell epithelioma occur, although Lacassagne, in a comprehensive clinical and pathologic study of 1,075 cases of epithelioma, denied the transition between basal-cell and squamous-cell epithelioma. He failed to refer to any of the articles mentioned previously. From 15 to 20 per cent of the basal-cell epitheliomas which are diagnosed clinically should prove on microscopic examination to be basal-squamous or squamous-cell epithelioma.² Basal-squamous-cell epithelioma represents, in the majority of instances, I believe, a true metamorphosis of basal-cell to squamous-cell epithelioma. Partial pearl formation, which characterizes many of these lesions, is composed of basal, intermediary, and prickle cells, resulting in incomplete keratinization, together with a

² Epstein in a study of epithelioma of the skin of the nose, found 96 basal-cell epitheliomas, four squamous-cell epitheliomas, and 15 basal squamous-cell epitheliomas (metatypical), though only 39 of the 96 basal-cell epitheliomas were proved histologically.

brightly staining colloidal center. The intermediary type of Darier lacks the partial pearl formation, and is composed chiefly of

dividual cells, as evidenced by his description of Bowen-like changes in both the original and metastatic lesions

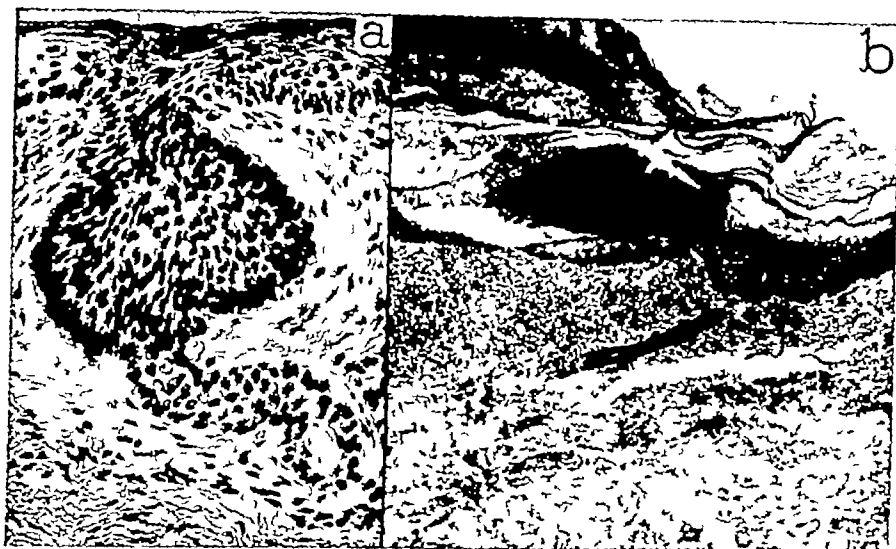


Fig 4 (A) Superficial epitheliomatosis back. Serial section and reconstruction revealed a basal-cell origin for this tumor, which surrounded the sweat duct but left the latter uninvolved, (B) typical lesion of superficial epitheliomatosis back of two years' duration, showing ulceration. Multiple points of origin from the basal cells of the epidermis at the left and right. Note the abrupt change and dense basophilic staining of the basal cells, which at the right side are surrounding a sweat duct which remains uninvolved.

cells which are intermediary in character between basal and prickly cells. In Haythorne's article, Figure 4, I believe, does not show a true hair follicle, but shows a parakeratin pearl of early basal-squamous-cell epithelioma. This is definitely different, I believe, from the benign, well-formed cysts, which are seen in verruca senilis, and from the rudimentary or completely developed hair shafts to be seen in various forms of epithelioma adenoides cysticum.

Neither the metatypical nor the intermediary form of basal-squamous-cell epithelioma should be confused with squamous-cell epithelioma Grade 3 or 4, or with those squamous-cell epitheliomas which disclose phenomena of keratinization of individual cells and clumping of cells, and changes that simulate Bowen's disease. From Juon's description and especially Figure 5 of his article of 1933, it seems that his case was not one of pure epithelioma metatypique intermédiaire, but was one of squamous-cell epithelioma with keratinization of in-

Metastatic Basal-cell Epithelioma—Basal-cell epitheliomas do not, I believe, metastasize as such. Careful search should reveal basal-squamous cell or squamous-cell changes in the original tumor as well as in the metastatic lesion, at the time of metastasis. The description of the pathologic changes, which was given by Niles, would indicate that this was so in his case (62). He reviewed the older literature, but incorrectly included the two cases, which had been reported by Finnerud, as metastatic basal-cell epitheliomas. I had already included these cases with basal-squamous-cell epithelioma because of their transitional character before metastasis occurred. He was correct in referring to Korb's Case 61 (erroneously labelled Case 6 in my paper, 55). To this I would also add Beadle's case and Janeway's case, all three of these, however, were reported twenty years or more ago. Both Broders and I (11) have yet to see a case of true metastatic basal-cell epithelioma.

Superficial Epitheliomatosis—I believe,

however, that the group of epitheliomas, which are usually basal-cell in character, and which Ormsby designated as superficial

cell or squamous-cell epithelioma, as compared with ordinary basal-cell epithelioma Arsenic has been suggested as an etiologic

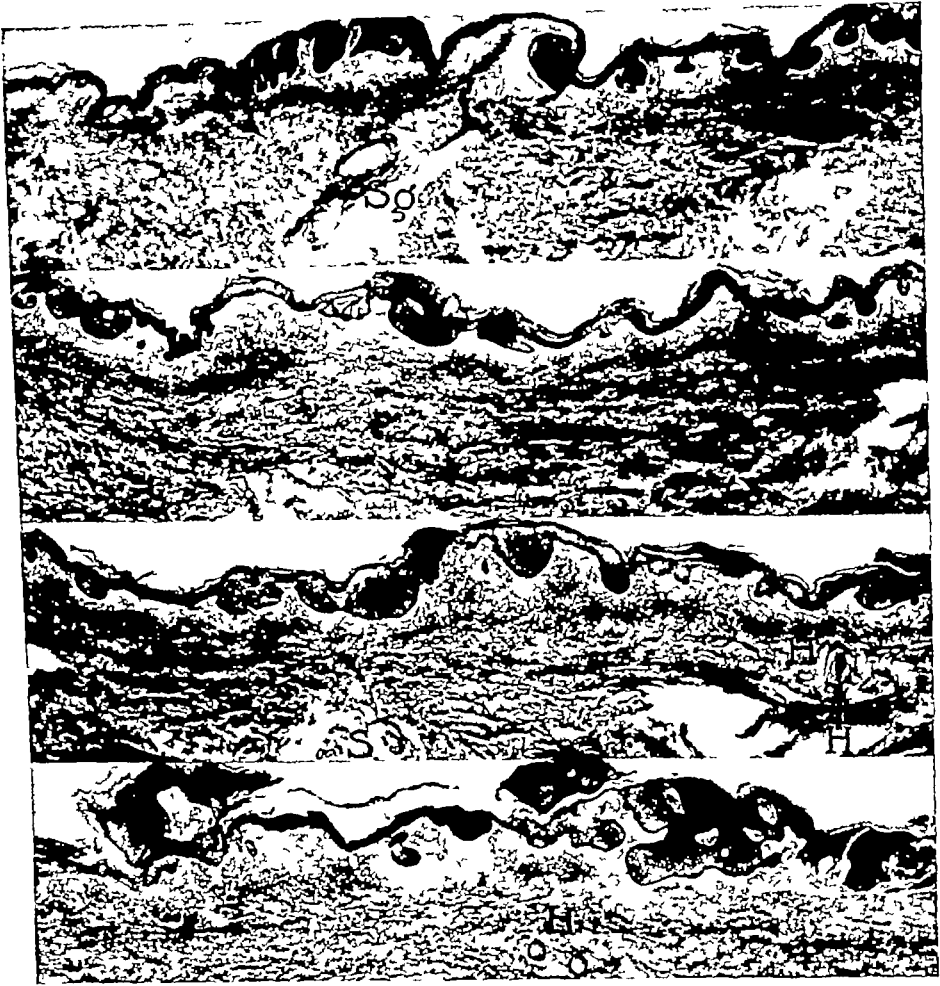


Fig 5 Typical lesion of superficial epitheliomatosis right lumbar region, about 2.5 cm in diameter, from a woman aged 52 years, who had had a lesion for 15 years. Consecutive series across entire width of lesion (right-hand edge duplicated at next lower left-hand edge), showing multiple basal-cell growths from at least twenty points of origin, also mature sebaceous gland (sg), hair follicle (h), and sweat glands (s).

epitheliomatosis (also referred to as erythematoid benign epithelioma of Little and multiple superficial benign epithelioma of the skin by Wise) offer an ideal field for study of their histogenesis. This is because of their predominance on the trunk and covered portions of the body, where they are removed from the influence of the actinic rays and, for the most part, also from trauma, and also because of their relatively benign character, slow growth, and less frequent change to basal-squamous-

agent for this group, by Anderson, but as I previously have pointed out (57), I believe he has confused cases of the arsenic type of epithelioma of the trunk with those of superficial epitheliomatosis. Franseen and Taylor, I feel, have fallen into the same error, and thus have a much higher incidence of the arsenic type of basal-cell epithelioma among these cases than is justly so. Confusion arises in cases in which both types of lesions affect the same individual. Before deciding that arsenic is the cause

of a basal-cell epithelioma, one should, as a rule, be able to demonstrate more arsenic in the epithelioma than in the adjacent normal tissue, admitting Fischer-Wasels' evidence that the administration of arsenic may produce a constitutional susceptibility to cancer, or accelerate dormant carcinomatous foci

A typical case of superficial epitheliomatosis of the dry type is usually basal cell in character, and reveals multiple points of origin from the epidermis. The lesions do not extend deeply, in many instances, it is possible to show by serial section that they are not connected with one another or with the hair follicles. I have seen origins from the basal cells of upper portions of the walls of hair follicles in a few instances but not from the hair matrix. It is interesting that, in contrast to benign basal-cell growths, I have been unable to trace true origin from the walls of a sweat duct (Figs 4-A and 4-B). Both of these cases revealed multiple and independent origin from the epidermis, but not from the walls of hair follicles. The proponents of the origin from the hair matrix could say that these are rudimentary hairs inasmuch as, in some mammals and occasionally in human beings, one can see sweat ducts which empty into the orifice of the hair follicle rather than in the epidermis. It is even more difficult, however, to assume in Figure 5, where serial sections reveal more than twenty independent basal-cell growths, that these all should represent rudimentary hair follicles, especially as the section is taken from the right scapular region, in which relatively few hairs are normally seen, and well-developed hair follicles and sebaceous glands, which are cut tangentially, can be seen in several areas, as well as well-developed sweat glands. Furthermore, Figure 6-A, which is from the same series of sections as Figure 5, reveals two separate basal-cell growths, which arise from the epidermis and not from the normal fully developed hair follicle which is present. No rudimentary hair follicles were seen in these sections, as are seen in epithelioma adenoides cysticum. One would expect

transitional forms to be present if the twenty or more basal-cell growths were of hair follicle or hair-matrix origin. The earliest stages of basal-cell epithelioma, as seen in many cases of superficial epitheliomatosis and in cases in which only a few dozen neoplastic cells are present, may simulate embryonic hairs (see illustrations by Pinkus (68), and by Lewis and Stöhr). Both of these growths show basophilic staining, but the basal-cell epitheliomas reveal larger and more immature forms of basal cells and more mitotic figures than the benign type of growths. The basal-cell growth in superficial epitheliomatosis present a definite band of *Gitterfasern* surrounding the growth. Squamous-cell epithelioma may also arise from the walls of hair follicles, as is seen in Figure 6-B.

Studies of superficial epitheliomatosis therefore confirm and support the origin of basal-cell epithelioma from the basal cells of the epidermis.

Melano-epithelioma—If we believe that dendritic cells are modified forms of basal cells, then melano-epithelioma must also be included in the group of malignant basal-cell epitheliomas. Many writers, however, support Masson's neurogenic origin for these lesions (21, 24, and 41). I have seen all gradations between so-called lentigo maligna (74) and melanotic whitlow to melano-epithelioma, arising from flat to verrucous elevated pigmented nevus (14 and 22). Broders (11) and I are in accord, however, with Becker, and believe that when a malignant change occurs it takes place first at the epidermal-cutis junction, and not, as a rule, deep in the nevus tumor. Whereas the greatest majority of so-called non-melanotic melano-epitheliomas will reveal small amounts of melanin in some areas, when stained with silver nitrate instead of with hematoxylin and eosin stains, this does not deny their relative lack of differentiation, and hence, their greater degree of malignancy than melano-epitheliomas. I do not deny the existence of melanoma, which arises independently from the epidermis, such as malignant change in the nevus blau of Jadassohn.

"PRECANCEROUS DERMATOSES"

Of the so-called precancerous dermatoses

ing the tissue and becoming clinically malignant Figures 7-A and 7-B are examples of this In my real cases of Bow-

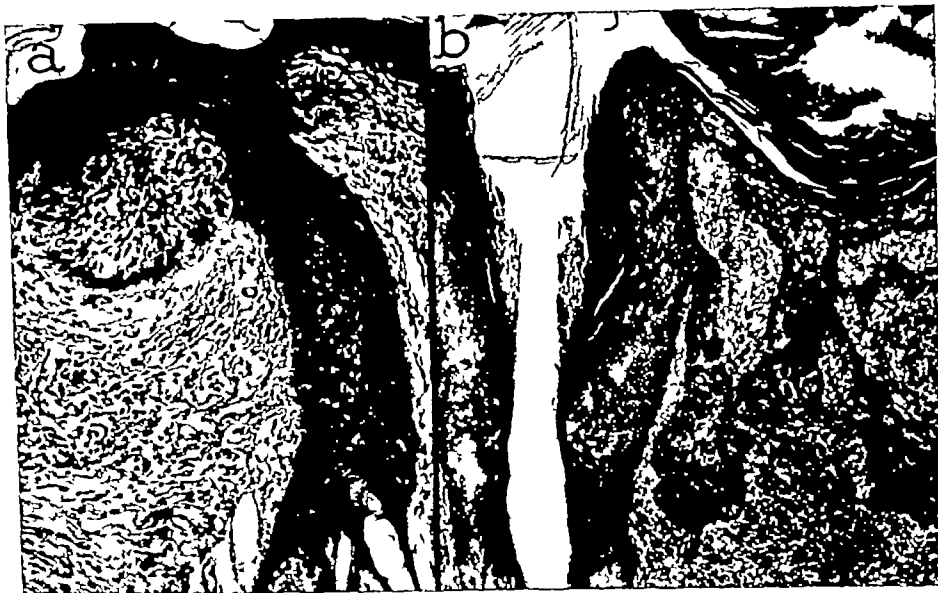


Fig 6 (A) Basal cell origin about hair follicle without involvement of latter (false hair follicle origin) Same case serial sections as Figure 5, (B) squamous-cell epithelioma Grade 4 cheek with multiple points of origin from epidermis and wall of hair follicle (Same case as represented in Figs 6 and 7 Montgomery and Doerffel)

(9), xeroderma pigmentosum frequently discloses malignant change in the form of basal-cell epithelioma, some of these growths originate in the hair follicles (59), and many show a considerable degree of pigmentation In xeroderma pigmentosum, basal-cell tumors predominate over basal-squamous-cell tumors, squamous-cell tumors, and even melano-epitheliomas, and occasionally even sarcomas In xeroderma pigmentosum, hereditary influences and sensitivity to light, especially to certain wave lengths of light (44), are outstanding etiologic factors

Studies of senile keratosis, and keratoses that are sequelæ of radiotherapy, arsenic, and tar, reveal that in less than 10 per cent of the cases in which epithelioma develops, is the epithelioma basal-cell in character When epitheliomas develop, they usually present the histologic picture of a squamous-cell epithelioma *in situ*, with individual cell keratinization, and simulate real cases of Bowen's disease, and may (56, 57, and 58) remain *in situ* for many years before invad-

en's disease, I have been unable to find morphologic evidence that would support the concept of some authors that this condition originated in the sweat or sebaceous glands (31 and 72) If, as I have found, malignant change develops in about 20 per cent of the cases of arsenic and senile keratoses, the incidence of basal-cell epithelioma in these cases would be less than 2 per cent This is not much greater than the incidence of carcinoma of the skin, in general, for the age group and the type of skin under consideration

SUMMARY AND CONCLUSIONS

Benign forms of basal-cell epithelioma, especially epithelioma adenoides cysticum and cylindroma, may arise from multiple points of origin, from the basal cells of the epidermis, and from the basal cells that form the outer sheath of the hair follicle, sebaceous gland, and sweat duct At times, they originate from the basal cells of the outer root sheath of the hair follicle, or even from the matrix cells near the bulb, without

evidence that the basal cells of the epidermis participate in the neoplastic process

Verrucae semilis may be designated as be-

The basal cells that line the outer sheath of the hair follicles, sweat ducts, and sebaceous glands are similar to the basal cells of



Fig 7 (A) Keratoma senile, back of hand showing very early squamous-cell epithelioma, Grade 1 *in situ*, with lack of involvement of the sweat duct and hair follicle, (B) arsenic epithelioma back, showing clumping of cells amitotic cell division and vacuolization of cells simulating Bowen's disease Squamous-cell epithelioma Grade 1 *in situ*

nign pigmented basal-cell epitheliomas (benign melano-epitheliomas), but I believe they are more properly designated as delayed epithelial nevi. The same holds true for nevus pigmentosus, which should still be classified as a nevus rather than a benign epithelial neoplasm.

Transitions between benign and malignant basal-cell epitheliomas, and multiplicity of type of lesions in the same individual, are seen, and justify the use of the term epithelioma to include both these types of lesions rather than confining epithelioma to benign neoplasms of the skin and carcinoma to malignant forms of same

the epidermis, and therefore may participate independently or simultaneously in any neoplastic process.

Malignant basal-cell epitheliomas (Basalzellenkrebs, Krompecher), which predominate in certain locations on the face, may rarely originate from the hair matrix, more often from basal cells of the outer root sheath of the hair follicle, occasionally may represent embryonic rests that are independent of the epidermis or any dermal appendage, but I believe that in the greatest majority of cases they reveal single or multiple points of origin from the basal cells of the epidermis. The latter in their

growth, may simulate imperfectly formed or embryonic hair follicles or sebaceous glands, but without possibility of connecting these growths in serial sections with the mature forms of sebaceous glands and hair follicles to be seen in the same specimen for biopsy. Silver stains, in my opinion, are not of value in distinguishing a basal-cell epithelioma from an epithelioma that originates in a hair matrix, and the presence of melanin does not determine the origin of the basal-celled growth.

Basal-squamous-cell epithelioma represents metamorphosis from basal-cell to squamous-cell epithelioma, and affords further evidence for the origin of basal-cell epithelioma from the basal cells of the epidermis. This denies a fundamental and separate histogenesis of basal-cell and squamous-cell epitheliomas.

The early development of basal-cell epithelioma from multicentric and independent points of origin from the basal cells of the epidermis is best seen and studied in many cases of superficial epitheliomatosis. The presence of mature hair follicles, sweat glands, and sebaceous glands, without evidence of transitional forms, speaks against a hair follicle origin for these tumors.

Basal-cell epitheliomas are seen in 10 per cent or much less of the cases of epithelioma, which are the result of senile keratoses and keratoses from arsenic, tar, and radiotherapy (33), or less than 2 per cent of all the cases of the keratoses from these causes. The greatest majority of these lesions are squamous cell in character.

It is necessary to demonstrate the origin of a given basal-cell epithelioma from the epidermis or dermal appendages by serial section and various reconstruction methods before deciding that it originates from these structures. In regard to arsenic as an etiologic factor, the presence of arsenical keratoses or pigmentation does not confirm that a basal-cell epithelioma is caused by arsenic, in general, one should demonstrate that more arsenic is present in the epithelioma in question than is present in the normal adjacent epidermis.

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CARCINOMA OF THE MOUTH

WITH ESPECIAL REFERENCE TO TREATMENT¹

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IN frequency, cancer of the mouth ranks second to that of the breast and uterus

It is among the most accessible, yet highly fatal, of cancers, with a mortality rate of from 75 to 90 per cent. The lesions are readily recognizable, yet tend to early disintegration, infection, and regional spread. For example, the frequency of enlarged cervical nodes at the time of admission is reported, for lingual and sublingual cancer, as follows

	Per Cent	
Iahr	82	
Kuettner	75	
Lenz-Dubois Roquebert	94	L'Institute du Radium
Menegaux	69.9	103 cases
Quick	50	450 cases of tongue cancer
Roux Berger and Monod	80	Inoperable or borderline
Sachs	82	

If these figures can be accepted, then, on the average, 73.3 per cent of the patients present themselves with enlarged cervical nodes, whether infectious or carcinomatous; no one can reliably predict which

Mouth tumors are best classified for study according to location, *viz*

- Cancer labii
- Cancer linguae
- Cancer sublinguae
- Cancer gingivae and mandibulae
- Cancer buccae
- Cancer palati—duri and molli
- Cancer tonsillae
- Rarer types

The lip, tongue, floor of the mouth, and cheek are the sites most frequently involved, the palate and gums are more rarely attacked. By mandibular cancer we understand those cases which, extending from the mucous membrane, gingiva, offer as their chief symptom thickening of the

lower jaw bone. They are often diagnosed grossly as sarcoma of the jaw.

Cancer of the maxilla, only as it may arise in the alveolar margin of the upper jaw, is considered. Oehngren's (81) classical review of 187 cases of maxillo-ethmoidal malignancy, the largest series yet reported, clearly demonstrates the effectiveness of radium as an adjunct to surgery, especially electro-surgery of this region.

Treatment of cancer posterior to the faucial pillars, namely, of the nasopharynx and larynx, is indispensably radiologic, with the possible addition of laryngectomy for intrinsic carcinoma of the larynx. Since Coutard (16), in 1921, reported 22 cases, with primary healing in 80 per cent, using heavy doses (5,000–8,000 r) of roentgen radiation through the tissues of the neck, his technic has become more or less standard.

HISTORICAL

Our chief concern is with the rapid changes in therapy since 1900. The Indians, Egyptians, and Persians (1000 B.C.) recognized cancer and attempted to treat it (118). Hippocrates (460 B.C.) knew a great deal about the recognition of cancer, having described many forms, *ie*, skin, breast, stomach, cervix, and rectum. He originated the term "carcinoma." His therapy was weak, only caustic pastes and the cautery were recommended.

The first plastic surgery for cancer was done by Celsus (100 A.D.). He removed the breast, and excised cancer of the lip and face.

A century later Galen, the founder of humoral pathology, taught that cancer originated from *atra bilis*, the black bile. He nullified Celsus' approach to the more correct surgical treatment. His bold teachings led away from the scalpel, and limited therapy to the internal and external use of

¹ Undertaken during 1933–1934. Alexander Cochrane Bowen Travelling Scholarship. New York Academy of Medicine.

medicaments, chiefly purgation and blood-letting. For more than a thousand years his teachings were firmly adhered to, *1 c*, "Nam incurabilia sunt omnia ulcera ex atra bile facta." Corrosive, caustic pastes, and the cautery (*ferrum candens*) were the sole adjuvants.

Only with the beginning of the nineteenth century were the philosophic systems of the ages and the empirical traditions of the Middle Ages thrown overboard. With the aid of the magnifying lens and the microscope other conceptions of the essence and significance of cancer were reached. By this time the French and German barber surgeons, with knife in hand had long solved the question as to how cancer should best be treated.

Phases in the treatment of cancer of the tongue

	A D	
Paul of Aegina	700	Devised instrument for stilling hemorrhage from the tongue
Petrus de Marchetti	1664	Extirpation with the hot iron
Laurentius Heister	1743	First methodical presentation of the medical and operative treatment of tongue cancer
Inglis	1805	Ligature of the tongue
C J M Langenbeck	1819	Wedge shaped excision
Jaeger	1831	Splitting of cheek
Mirault	1833	Preventive ligation of arteria lingualis
Roux	1836	Splitting of mandible
Reguda	1838	Extirpation from supra-hyoid approach
Middeldorpf	1854	Galvanocautic
Billroth	1862	Osteoplasty—resection of the lower jaw
Kocher	1880	Extirpation of base of tongue

In 1829, the French surgeon Recamier first recognized the process of metastasis. He used this term to describe secondary growths in the brain occurring in mammary carcinoma.

William Hunter's discovery, by mercurial injections, in 1746, that the lymphatics were independent of the arteries and veins, led to an intense study of the anatomy of the lymphatics. Injections of wax, lard, oil of turpentine and lavender, gelatin, plaster and alcohol were variously tried. Sappey, a leading French anatomist, in

1874, refined the mercury technic and made anatomic charts of lymphatic areas. At this time the surgeons awakened to the importance of lymphatic drainage for cancer surgery. The earliest radical operations were based on Sappey's charts.

The finest lymphatics were ruptured by the force necessary to inject mercury and wax. In 1896, Gerota (Berlin) obtained clearly the best preparations by injecting a suspension of Prussian Blue in turpentine and ether, using capillary glass pipettes.

In 1898, Kuettner (60), using Gerota's technic on 15 cadavers, filled in the gaps of our knowledge of lymphatics of the tongue, floor of the mouth, and cervical drainage areas. He advised early and wide excavation of the cervical lymphatics in tongue cancer.

In 1900, Dorendorf (29) followed Kuettner's lead by studying in detail the lymphatics of the lip on 20 cadavers, using Gerota's technic.

Crile (26) in 1906, outlined systematically our present "block dissection" technic, which he had performed in 132 cases since 1898. His technic is basically standard today. His operative mortality of 8 per cent in an era of one-stage operations, on debilitated patients, compares favorably with the present rate.

The turn of the century brought the x-ray through Roentgen (1895), and radium through Mme Curie (1898). Roentgen therapy obtained its first cancer cure when Tor Stenbeck (Stockholm), in 1898, treated a basal-cell carcinoma of the nose that had recurred twice after coagulation with the red-hot iron. Forssell (41) followed that patient until 1920. There was no recurrence.

Soon after the discovery of radium, experiments were made on plants and animals. In 1899, Becquerel carried a tube of radium in his waistcoat pocket for some hours and received a severe radium burn on the underlying skin. This experience led eventually to its use in the diseases of man.

In 1903, S W Goldberg (St Petersburg) applied radium to his own arm. A slowly healing ulcer developed. Suspecting that

radium would have a striking effect on cancerous epithelium, he, together with E S London, treated two cases of basal-cell carcinoma of the face, with good cosmetic result. The authors recognized that they had discovered a new and valuable method of treating cancer. The widespread empirical application of radium and x-ray, however, soon burst the bubble of expectancy, and spread a train of failure in its wake. Little success was at first obtained outside the field of skin cancer.

Dominici (28), in 1907, outlined the method of filtration to cut out the softer rays irritant to the tissues. In 1908, he spoke of treating cancer of the tongue with radium, recognizing that the failure of x-rays against tongue cancer was almost complete. In 1910, he announced his method of implanting radium needles in cancer of the tongue. Manifest regression of the tumor, followed by less pain and hemorrhage, resulted.

Further development in France was then held up during the World War. Stevenson (107), in 1914, in collaboration with the Radium Institute of Dublin, first made needles charged with radon emanation. In 1916, he buried fine glass capillary tubes filled with radon, without further filtration, into tumors of the tongue. This method has since been further developed in America, through the work of Failla, Jane-way, and Quick at the Memorial Hospital in New York City. According to Quick (87), in 1934, the unfiltered glass seeds used from 1916 to 1925 saved more cases than any other form of radiation, even though at the expense of great suffering because of necrosis. Failla, in 1925, was able to seal emanation in capillary glass tubes with 0.3 mm gold filter, thus lessening the necrotic action, increasing tissue tolerance to larger intratumoral doses, and thereby overcoming the chief objections to the use of radon seeds. Quick (86), in 1929, reported 450 cases of tongue carcinoma, with 22.4 per cent free from disease from three to ten years, using this method in combination with surgery and cauterization.

However, the use of radon seeds has been

little fostered outside of central cancer clinics of America. Regaud, who prefers a constant source of radiation—the element needles—feels that the 0.3 mm gold filtration is inadequate. To make the filtration 0.5 mm gold would increase the bulk of the seeds and make their permanent insertion less desirable because of foreign body reaction. Regaud (91), in 1929, reported 344 cases of tongue cancer (from 1920 to 1926), with 23.8 per cent cures for at least three years, using intra-tumoral element needles.

The Radiumhemmet, Stockholm, having large amounts of radium element (10 grams), with comparable results, finds few advantages and little reason for introducing an emanation plant, expensive and complicated to maintain (Ahlbom²). Ber-ven (9) reports 278 cases of oral cancer treated, from 1916 to 1926, with 27 per cent five-year cures.

In radiation therapy of intra-oral cancer, since 1910 the pendulum has swung ever more strongly toward the intra-tumoral application of radio-active substances. Since Martin, Quimby, and Pack (69) showed, in 1931, that the minimal lethal dose required for the successful treatment of intra-oral cancer (56 cases) was from 7 to 10 skin erythema doses, if delivered in from 10 to 20 days, the unsatisfactory position of external radiation has been more clearly defined. The intensity of the oral tumor dosage, from an external source, rarely reaches 2 SED, and never exceeds 3 SED without serious damage to the tissues and often a fatal effect on the patient.

Since 1920, the development of telera-dium treatment (mass radiation from a distance, the radium bomb) has been steady. Its wide use in France, England, Sweden especially, and in America has already led to the impression that it is superior to x-ray therapy in the intra-oral field. Its most ardent, reliable proponent, however, the Radiumhemmet, in Stockholm, employs it only in combination with later electro-coagulation, "needling" or surface radium to intra-oral tumors, and as a measure pre-operative to dissection of cervical metas-

² Personal communication August 1934.

tases Its ultimate usefulness has not yet been ascertained Its striking effect on carcinoma of the tonsil, in Berven's hands, we shall refer to later

PATHOLOGIC ANATOMY

Of the malignant tumors of the mouth, epidermoid carcinomas, usually of the adult differentiated type, comprise over 90 per cent In general, there are two types of cancer of epidermoid origin the acanthoma, with adult squamous cells, hornification and pearl formation, and basal-cell carcinoma, the so-called rodent ulcer The basal-cell lesion is extremely rare in the mouth Broders (19), in his wide experience at the Mayo Clinic, has never seen a case The acanthomas, with varied degrees of hornification, thus dominate the group, plus a few rarer types

The mouth and urinary tract have a protective covering epithelium, in contrast to the secretory, glandular epithelium of the gastro-intestinal tract Hence the buccal epithelium differs from normal epidermis only in its lack of pronounced superficial squamous characters It has been studied intensively in its relation to carcinoma by Mekie (74) and Fraser (44) Fetal buccal epithelium is composed of a single cuboidal layer The superimposed prickle cell and keratinized layers in the mature epithelium are regarded as layers of cells in the process of degeneration, without power of multiplication The cuboidal, basement cell alone has the power of reproduction and of invasion (Ewing, Broders, Mekie) All others are in a stage of degeneration, due to partial starvation and poor oxygen supply This results from crowding of the intercellular spaces, with diminished play of nourishing intercellular fluids as the cells are forced to the uppermost layers of the epithelium

Ewing divides epitheliomas of the lip into (1) the papillary, wart-like, slow-growing type, and (2) the ulcerative, infiltrating, more malignant type The latter lies beneath rather than in the epithelial layer, ulcerates early, with much inflammatory reaction, and may involve the lymph

nodes early, which latter, however, seldom become large The papillary form may eventually infiltrate deeply

The tongue epithelium is similar to that of the buccal cavity Fraser (44) could find no structural peculiarity to explain the predominance of cancer in the anterior two-thirds of the tongue The intra-oral lesion is usually a hard indurated ulcer, sometimes more papillary and nodular In the tongue the arrangement of blood vessels and lymphatics may somewhat restrict the growth to one lateral half or to the base, but advanced lesions invade both sides, extending from the base in all directions, and from the tip to the floor of the mouth The tongue edges are the most common locations (Woelfler, 55 per cent, Fraser, 62 per cent), and the dorsum and posterior third are the least

The majority of lesions of the floor of the mouth are localized around the openings of the salivary ducts, at the side of the junctional epithelium (Fraser) They may show cylindrical cell structure, suggesting salivary gland origin Tumors arising from the tongue borders and alveolar margin of the jaw are prone to invade the sublingual region As elsewhere, infection, ulceration, and early progression to the cervical nodes occur Primary lesions may likewise extend actively to the lip, gums, and tongue as well as to the deeper structures

Mandibular cancer arises from the gingiva, usually beginning around an infected tooth as a warty ulcer or growth with raised, everted edges Squamous characters are generally pronounced It rapidly invades and destroys the jaw, extending to the maxillary antrum if in the upper jaw, or outward to the skin if in the lower jaw The mandible thickens and is painful, with ulceration usually on its alveolar margin

The buccal lesion, likewise indurated, is ulcerated and superficial from the first It extends actively, with much pain and discharge, to invade the loose, thin layer of tissues of the cheek, with fixation of the overlying skin It arises from fissures, abrasions, and erosions Lymphocytic infiltration and edema of the submucosa, as

elsewhere, nearly always precede the down-growth of epithelium

Malignant tumors of the tonsil, both carcinoma and sarcoma, are more cellular, anaplastic, and rapid-growing as a group. They become infected, ulcerate, and extend widely into neighboring structures without demarcation, and metastasize early. Since 1921, the following classification has been evolved

Carcinoma

Squamous-cell epithelioma-adult, resistant, spinal-cell type

Transitional-cell epithelioma-	} undifferentiated, no keratin or pearls
Lymphoepithelioma	

Sarcoma

Usually lymphosarcoma

These will be discussed under the rarer types of tumors

LYMPHATIC DISTRIBUTION

This determines the chief metastatic paths to the neck. The lymph vessels from the upper lip course right and left to the anterior facial vein, and follow the external maxillary artery through the digastric triangle to the upper deep cervical nodes.

From the lower lip two sets of vessels course to the right and left, without crossing to the opposite side, except in the central lip area. The submucous vessels are the larger, emptying into the numerous small nodes lying close on the submaxillary salivary gland. The smaller subcutaneous vessels empty into the submental nodes. It is important to recognize that the submental, submaxillary, superficial, and upper deep cervical nodes may be involved. Unless the lesion is in the midlip, bilateral or crossed metastases occur but rarely.

So rich are the lymphatic networks of the tongue, floor of the mouth, and neck that metastasis from any mouth tumor may deposit in any node of the neck. The lymphatics of the anterior half of the tongue have separate origin from those of the base, yet all paths lead to the cervical groups. Cancer of the tongue seems to involve the upper deep cervical group primarily,

whereas cancer of the floor of the mouth first attacks the submaxillary group (Woelfler). Cancer at the tip of the tongue or sublingually near the frenum passes first to the submental and sublingual groups, and may involve the deep cervical nodes bilaterally.

There are four cervical lymphatic groups of special interest. The lingual and submental nodes lie on the mylohyoid muscle and between the genio-hyo-glossal muscles. They are part of the system that drains the lip, anterior tongue, and buccal floor.

The submaxillary group lie principally in the digastric triangle, are adherent to the capsule of the submaxillary salivary gland, and are continuous with other nodes that extend as far back as the parotid gland. This group drain the border of the tongue as far back as the fauces, the central part of the anterior half of the tongue, and the under surface of the tip and floor of the mouth.

The superior deep cervical group lie on the sheath of the internal jugular vein and on the carotid artery, extending upward as far as the base of the skull, and draining all parts of the mouth, tongue, fauces, and upper pharynx. The largest and most important node lies at the bifurcation of the common carotid or slightly higher. Anastomosing with this group is a small cluster of nodes at the lower pole of the parotid, which drain the anterior surface of the palate.

The inferior deep cervical nodes lie on the jugular vein at the crossing of the omohyoid muscle and extend down behind the clavicle. They receive branches directly from the apex and base of the tongue. The terminal branches empty directly into the jugular and subclavian veins, independent of the thoracic duct, on the left side. Both the deep groups are more or less covered by the sternomastoid muscle and are adherent to the deep layers of its sheath.

RARER TYPES

The majority of intra-oral malignancies arise from the buccal pavement epithelium. The rare exceptions are

Sarcoma—Soft-part sarcomas of the mouth, if giant-cell epulis is excluded, are very rare. They are mainly the round-cell type. The newgrowths arising from bone, *i.e.*, medullary or periosteal sarcoma, or tumor-like osteitis fibrosa are much more frequent. The latter occur in younger age groups, and equally in both sexes, as opposed to carcinoma.

Lymphosarcoma—This type occurs more frequently in the nasopharynx.

Nerve Cell Tumors—These are neurofibroma, neurinoma, and glioma—even rarer.

Transitional-cell Epithelioma—In 1927, Quick and Cutler (85), from a large series of cases of intra-oral cancer, selected 20 cases which had shown striking regression of the tumor after small doses of external radiation. They found that these tumors had a peculiar histologic structure. The cells resembled transitional epithelium, they lacked the flat pavement characters, spines, hornification, and pearls of the usual squamous growths. The tumors were most common in the base of the tongue, tonsil, and pharynx, where transitional epithelium has been found.

The diagnosis is difficult. They are confused with branchiogenetic carcinoma, endothelioma, lymphosarcoma, and reticulum-cell sarcoma. Ewing (37), studying 300 intra-oral tumors, stated (1929) that "the more rapidly growing forms I find difficult and almost impossible to differentiate from other forms of carcinoma." Beren³ believes these tumors to be indistinguishable both clinically and pathologically from sarcoma. Of Quick's and Cutler's original 20 cases, 13 died within 18 months. The remaining seven had not yet reached that limit.

Lympho-epithelioma—In 1921, Schmincke (99), of Munich, and Regaud, of Paris, independently called attention to certain oro-pharyngeal tumors, usually diagnosed as sarcoma, whose histologic characteristics consisted of embryonal epithelium growing in intimate association with lymphocytes. They believed that the epithe-

lium covering the lymphoid deposits of the nasopharynx, especially of the tonsil and base of the tongue, was fundamentally modified by a symbiosis with the lymphocytes, also, that this tissue should be regarded as a specific organ, called lympho-epithelium (Jolly), giving rise to a specific group of tumors.

Schmincke reported 10 cases, describing five convincingly from the histologic and embryologic standpoint. He holds that the lympho-epithelium and its tumors arise from the entodermal epithelium of the pharyngeal pouches as do the tonsils and thymus gland, all three having reticulo-syncytial-epithelial structure intimately penetrated with lymphocytes.

The lympho-epitheliomas are all embryonal, hence their extreme radiosensitivity. Ewing regards the lympho-epithelium as definite, "but more work must be done to define the tumor group."

Carcinoma of Cylindrical-cell Origin—This type usually occurs in the floor of the mouth. It arises probably from salivary gland tissue.

Mixed Tumors—These are most common in the soft palate.

Epulis—Is this a tumor? Kaiserling (52) regards epulis as a granuloma, a productive inflammation characterized by giant cells, usually cell-poor, though it may be so cellular as to be confused with sarcoma. He suggests removing it from the true tumor group.

It is recognized clinically, however, as "semi-malignant." It tends to recur locally and to metastasize, it may be histologically benign and clinically malignant, its structure varies between a firm fibroma and a sarcoma, both of the giant-cell type.

Grossly, it appears as a pedunculated growth with narrow pedicle—projects between the teeth—arising from the periosteum of the alveolar margin or from the peridontium. It is dark bluish-red, covered with mucous membrane. It may perforate and bleed easily. The etiology is unknown. The lesion is common between the ages of 20 and 40 years.

The fibrous type responds poorly to

³ Personal communication, September 1934.

radiation and, hence, should be generously excised. Though the cellular type may respond well, the painful, slow-healing radio-ostertis that may easily occur restricts the use of radium (1-2 needles) to be followed by excision. The frequency of recurrence after excision must be kept in mind. With the bone drill and Gigli saw a partial segment of the regional mandible may be removed. Berven,⁴ using surface radium, failed to obtain primary healing in 30 per cent of his cases. These went on to malignancy, developing neck metastases. Because of the difficulties of proper surface application he now implants needles.

Johnson (57) states that the treatment is emphatically not by irradiation alone but by cautery removal and irradiation of the base of the wound.

Adamantinoma —The so-called epithelial (rather than cystic) odontoma is composed of masses and anastomosing strands of epithelial cells which are believed to originate from an enamel organ or from islands of epithelium, the paradental remains.

The cystic types are often benign, while the solid are destructive and invasive.

ETIOLOGY

The direct cause, as for cancer elsewhere, is not known. A confusing mass of information has been gathered about associated conditions which seem to influence the appearance and course of the disease. Syphilis, the use of tobacco, leukoplakia, and defects of the teeth play the important part. In many cases, all of these may be present.

Syphilis —While this has been exaggerated as an etiologic factor (Bloodgood, 13), it is important for the following reasons.

(1) Because of its high incidence in mouth cancer (Simmons, 16 per cent, Fraser, 14 per cent, and especially in cancer of the tongue, Ehrlich, 30 per cent, Berven, 30-35 per cent, Quick, 35.1 per cent, and Judd and New (27) believe it to be even higher).

(2) Because of the changes it causes in the tumor bed, rendering the tumor

markedly resistant to all forms of radiation and to surgical healing.

(3) A positive Wassermann may mask the diagnosis of cancer coincident in the same lesion, with loss of valuable time.

If present, syphilis almost always exists in the same ulcer as the cancer of the tongue (Judd and New). In every mouth ulcer, regardless of the Wassermann reaction, cancer can be excluded only by biopsy. Specific treatment should be begun at once.

Tobacco —This is a local or general irritant rather than the drug producing the disease. Mouth cancer preponderates in males to the proportion of eight to one, most of them being strong smokers. In Broders (18) 537 cases of lip cancer, 78.5 per cent were pipe smokers. Ludwig found that the same dry products of combustion occur in tobacco smoke as in soot, tar, and paraffin.

Leukoplakia —Without question this, especially the warty type, is a pre-cancerous condition. It is an inflammatory lesion, seen particularly in smokers and drinkers, with syphilis present in from 45 to 90 per cent of cases (Kaiserling, 52). It is present in four or five of every 100 men under 40 years of age (Ducuing, 29-a), and is ten times less common in women.

These "smokers' patches" occur preferably on the anterior dorsum and edges of the tongue, also on the lip and buccal mucosa, near the angle of the mouth. Fissures may occur. The lesion develops slowly as a spotty thickening of the buccal epithelium, with marked keratohyalinization. The underlying submucosa in the early stage shows chronic inflammation, edema, with distended venules, loose fibrous tissue, and lymphocytosis. The papillae are increased and elongated. In pure old cases the inflammatory changes are scarcely demonstrable. According to their age, the plaques are cloudy gray or shiny mother-of-pearl, mostly sharply bounded, with a narrow red border. There is often great difficulty in differentiating the lesion from beginning cancer. Often the basal-cell layer is no longer sharply outlined. Atypical downgrowths of epithelium may occur.

⁴ Personal communication September 1934.

Clinically, there is at first slight burning, with superficial white spots. The tongue may become stiff. Swallowing and speech may be difficult. Elevation and cornification of the lesion ensue, followed by fissures, bleeding, a typical downgrowth of epithelium, carcinoma.

Fournier (43), in 1900, in studying 324 cases of leukoplakia buccalis found that in 30 per cent of the cases leukoplakia went over to cancer. Of 95 tongue cancers, 65 had both leukoplakia and cancer, 259 cases had syphilis.

Leukoplakia leads all other pre-cancerous lesions in importance. Every case is curable. It should be treated without delay, at first conservatively, *i e*, clearing up of mouth and gastro-intestinal disorders. When the lesions are early and not extensive, magnesium sulphate one gm. in one liter of water, taken in amounts of one glass three times daily, should show improvement in three weeks. The older lesions should be removed with the electrothermic loop to a depth of a few millimeters, under local anesthesia, in the clinic or office.

Defects of the Teeth—It is common knowledge that cancer has frequently developed at the site of long-standing direct irritation from a broken, sharp-edged tooth or from an ill-fitting denture.

Mouth Infection—This is the most constant finding, occurring in 50 per cent of the cases. Papillomas, fissures, chronic glossitis with hypertrophy and thickening, ulcers of any type should be recognized as pre-cancerous states. Judd and New have reported five cases with pre-existing actinomycosis.

Heredity—This plays no important part. The sporadic cases reported seldom exceed 2 per cent.

Alcohol—This may play its part as an irritant. The incidence of mouth cancer is higher in countries where the drinking of raw spirits is prevalent (Fraser, 44).

DIAGNOSIS

The lesion is usually a hard indurated ulcer, sometimes more papillary and nodular. Except for lesions of the posterior

tongue, the diagnosis of cancer on the foundation of biopsy should be readily made. Tongue cancer posterior to the circumvallate papillae is difficult both for the patient and the physician to recognize. Any ulceration of the mouth of more than two weeks' duration should be investigated from the cancer standpoint.

The first symptom may be enlarged cervical nodes. While these may be inflammatory, they should be regarded as cancerous in the treatment of the patient. Once cancer invades the cervical nodes the chance for cure is practically lost. Mekie (74) found, in 268 collected cases of mouth cancer with cancerous neck nodes (cases of Forssell, Quick, and his own—1932), only 8 (or 2.99 per cent) cured. Simmons (103), in 376 cases of mouth cancer, reported 5 per cent surgical cures in patients with clinical metastases and none by radiation (which was admittedly inadequate in dosage). Further, he states that even in early cases no reliance can be placed on the presence or absence of cervical nodes as an index of metastasis.

This meager chance of cure, once the neck nodes are invaded, should be meditated seriously by those who would temporize or moderate the treatment of the cervical lymphatic areas in primary cancer of the mouth. Bloodgood (13) sounded the important note in 1921, stressing propaganda for earlier diagnosis by education of the public, the medical and dental professions, stating that this can save more lives than any improvement in surgical technic, x-ray, radium, or cautery.

The differential diagnosis is generally well controlled by the free use of biopsy, followed by treatment without intervening delay.

Simple ulcers from pressure of teeth or plates may be found.

Leucemia—This may cause gangrenous ulcers of the mucous membrane (ulcerative stomatitis), swelling of the lymph nodes at the base of the tongue, plus bleeding gums.

Agranulocytosis—This, with mouth ulcerations, may be differentiated by the more acute systemic prostration plus leukocytopenia.

Tuberculosis—This as a mouth disease is much rarer than syphilis, in spite of the fact that the possibility and frequency of mouth infection with tubercle bacilli is greater than with spirochetes. However, tuberculosis is fairly common in the tonsil (Burnam).

Actinomycosis—This arises usually by injury to the soft parts by hard grains, and may form a small tumor mass, usually at the tip or edge of the tongue or floor of the mouth. It can awaken the suspicion of cancer, it is also confused with gumma and tuberculosis. The diagnosis is made by the yellow transillumination, the superficial site in the mucous membrane, the pea size, and the granules of yellow *Actinomyces*.

Diagnosis from the pathologic picture alone has its limitations. At times, even the most practised histologist cannot decide between chronic ulcer, syphilis, tuberculosis, and cancer, when there is a typical downgrowth of epithelium. Borst and Kaiserling (52) are astounded at the ease with which atypical epithelial growth, leukoplakic hyperplasia, and cancer are differentiated. They are likewise astonished at the scanty histologic evidence, believing that this may be a factor in the more favorable results reported.

PATHOGENESIS

Generally the degree of malignancy increases as one passes from lip to pharynx. Tumors of the mouth are chiefly of the adult, differentiated type. The added factors of decreasing accessibility to treatment, increasing vascularity of the tumor bed, association with vital structures, and the activity of the muscles of the tongue and floor of the mouth favor spread of the disease. Thus malignancy is seen to be lowest in lesions of the lip and cheek, and progressively higher in those of the tongue, floor of the mouth, and tonsil.

Spread of the disease occurs by direct extension and chiefly by metastasis. It is generally accepted that the latter occurs by embolic dissemination of the tumor cells, usually through the lymph channels. Evidence of spread *via* the hematogenous

routes is scanty. Single cases of implantation metastasis in the esophageal, gastric, and duodenal mucosæ after cancer of the tongue (Von Bergmann, 112, 1881) and in the bronchial nodes by aspiration (Lenz and Sproul, 65, 1934) have been reported. Secondary transplant by contact, *i.e.*, cancer of first the lower, then, five weeks later, of the upper lip at the point of contact (Von Bergmann), and of the cheek in contact with tongue cancer, have been sporadically reported.

Metastases from oral cancer are regional rather than remote. They are most always confined to the barrier of the cervical lymphatic groups. Remote metastases are very rare. Crile (26), in 1906, found less than 1 per cent in 4,500 statistical cases.

The clinical course is usually progressive, to become fatal in the average of two years—somewhat longer for cancer of the lip. The course is more rapid in the lingual cases, commonly from 6 to 12 months, and in pharyngeal tumors, from 4 to 10 months. Most metastases seem to have arisen from 5 to 6 months after the perceived onset of cancer of the tongue (Berven and Simmons). The local and regional growths become secondarily infected, usually streptococcal, with necrosis and suppuration, toxic systemic effects, and emaciation. The chief causes of death are pneumonia, septicemia, edema of the glottis, and hemorrhage. Ewing (35) stresses the frequency with which secondary infection with the streptococcus complicates or dominates the later stages.

ESSENTIAL PRINCIPLES OF RADIOTHERAPY TO PRECEDE SURGERY

Treatment resolves itself into the use of surgery (electro-surgery) or radiation, or both. The problem so difficult to-day is to see in its proper light the value of the innumerable combinations of radiotherapeutic measures proposed. The results of presumably good radical surgery (Kuettnner, Crile, Bastianelli, Zweifel-Payr), carried out during the preceding thirty-five years (1898) seem fairly well standardized in yielding the absolute rates of between 10

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and 20 per cent, averaging 15 per cent of five-year cures

We have seen that since 1910, roentgen and radium therapists have increasingly taken over the radiation of intra-oral cancer. We hear repeatedly that there can be no standard uniform dosage against carcinoma or sarcoma because of their great variations, and because of the varied reaction of the tumor bed. However, it is felt here that the *rationale* of effective radiation therapy of intra-oral tumors can be placed within definable, workably uniform limits.

First of all, the selective action of the roentgen and radium rays has been given thorough trial in the intra-oral group. By selective action is meant the administration of dosages sublethal to the adjacent normal tissues, yet causing disappearance of the tumor. This selective action shows its effect best on the undifferentiated embryonal tumor types, which, except in the tonsil, are rare in the mouth. We have seen that the usual adult epidermoid carcinoma requires for its destruction at least from 7 to 10 SED to all parts of the growth, whether x-ray or radium be employed. This dose is definitely lethal to normal epithelium and connective tissue. Thus for the reliable destruction of intra-oral tumors, the caustic rather than selective action of radium is largely called upon.

Secondly, external radiation, limited by the maximum tissue tolerance of 2.5 SED, *per se*, cannot approximate the intensity dosage required for effective treatment of either the primary or metastatic lesions of the intra-oral group. As a preliminary adjuvant measure it has a place, not to be over-evaluated.

Roentgen and radium rays belong in the series of electro-magnetic ether waves. On living tissues both act not as heat, producing inflammation and necrosis, but they injure the vitality of the cell, causing slow death. The younger the cell, the more intense the effect. Theoretically the correct dose injures only the tumor cells. In other respects roentgen and radium rays are quite different. Roentgen rays are produced by electric current in a vacuum tube, radium

rays arise from destruction of the radium atom, yielding emanation. The end-product of radium destruction is non-radiant lead.

Radium and its salts give off three kinds of rays—alpha, beta, and gamma. Alpha rays, composed of atoms of helium, are cast off the radium molecule. They have feeble activity and are all arrested by the container of the radio-active substance. Beta rays are composed of electrons and are of considerable vitality. They are comparable to cathode rays and are arrested by a thickness of 0.1 mm of gold or platinum. The alpha and beta rays are important therapeutically only in their injurious effect upon tissue, causing necrosis, hence they should be excluded as much as possible.

The gamma ray is very different. It is a vibratory type, has the same quality as the γ -ray, and has essentially the vitality of light. But the wave length is infinitely shorter than that of the x-ray (0.017 Ångström unit), and these rays are much more penetrating. Just as for x-ray, there are in the gamma radiation an infinity of rays of different wave lengths of unequal penetration. These softer rays are cut out by increasing the thickness of the filter to 1 mm of platinum.

When a gamma ray falls on an object this emits a new radiation, γe , a secondary radiation of softer rays having injurious, necrotic action. The hardness of these secondary rays rises with the atomic weight of the secondary radiator, γe , slight from loose connective tissue, hard from bone. To diminish secondary radiation of the tissues, the radium tubes should be placed as far as possible from substances with high atomic weight, namely, bone, to avoid necrosis.

The first experimenters used the necrotic action of beta and soft gamma rays in tumoral therapy. This is to be avoided for necrosis favors infection, the danger of hemorrhage is increased, and the tumor is replaced by an ulceration of radionecrosis, with little tendency to cicatrization.

Most therapists to-day use only the hard gamma rays. Some filter with more, others

with less, but all, except those using radon seeds, use at least 0.5 mm² of platinum, which stops all the beta and part of the gamma rays

The emanation, radon, namely, the first degeneration product of radium, may be collected and used in containers. It gives off the same quality of radiation but for a short time only, losing 50 per cent of its intensity in four days. The use of the element is more widespread and preferred because of its constant source of radiation. Failla's ingenious apparatus for collecting and sealing the emanation in gold filtered glass tubes has made the use of radon practicable in larger cancer clinics.

RADIATION REACTION

Following the application of radium, Ewing (34) describes the following more or less specific sequence of events. *From three to five days later*, hyperemia, lymphocytosis and polymorphonuclear leukocytosis, and swelling of all the cells, *second week*, the tumor cells are characteristic, with enlarged cell bodies, swollen, homogeneous, hyperchromatic nuclei, hydropic vacuoles in the cytoplasm and fusion of the giant cells, *third week*, the number of cells is reduced, liquefaction necrosis, invasion and compression by lymphocytes, and a proliferating stroma are seen, *fourth and fifth weeks*, only pyknotic nuclei and an occasional giant cell are seen, the stroma is active, and is impregnated with capillaries, leukocytes, plasma cells, and polyblasts. Eventually all becomes granulation tissue, followed by re-epithelialization. All variations of the above may occur.

The reaction of normal tissue, of the tumor bed, together with the direct action upon the tumor cells, determines largely the response of the tumor to radiation. Arteriosclerosis and syphilitic changes of endarteritis and fibrosis in the tumor bed diminish radiosensitivity and retard after-healing. Infected and necrotic tumors react less favorably. In fibrous and non-vascular areas the defense reaction is poor. Re-activated tumors, previously treated with inadequate amounts of radiation,

show increased resistance to further radiation. Repeated doses cause cicatrization, ulceration, immobility, constriction of vessels, nerves and hollow organs, pain and distress (Ewing). For these reasons adequate radiation should be given at one sitting or within one short period.

TREATMENT

It is imperative that treatment of the primary lesion and treatment of the regional cervical lymphatic areas be carried out without delay. It is quite generally agreed that small, early, easily removable lesions of the lip and mouth may best be excised. Advanced, inoperable lesions without question should be radiated. It is with the large intermediate group of operable and borderline cases that great confusion exists as to management.

Oral hygiene under supervision is important. This may be done during the period of preliminary external radiation. All areas of infection in the mouth should be corrected. Removal of septic teeth and painting of the gums night and morning with equal parts of tincture of iodine and tincture of aconite, plus frequent mouth washes, are recommended. Tobacco and alcohol should be reduced to a minimum. Anti-syphilitic therapy may be begun at once.

CANCER LABII

There exists no doubt to-day that the primary lesion can be effectively destroyed as well by varied forms of adequate radiation as by surgery. Radiation is preferred by many because of greater conservation of surrounding normal tissue, and, with re-epithelialization, less deformity and a better cosmetic result. This we believe to be true, judging from the controlled experience of the Radiumhemmet, in Stockholm, where the interstitial method has been routinely employed in cancer of the lip for eight years (since 1926).

Lesions of the lip under 1 cm. in size may be excised without marked deformity. For lesions over 1 cm., wide excision may be done, with plastic repair in cases in which

it is necessary, or the proved methods of radiation, as carried out by the larger, controlled clinics, may be employed

The following methods of radiation may be employed the minimum lethal dose of from 7 to 10 S E D may be administered by x-ray, with light filtration (1 to 2 mm Al) and careful screening of the surrounding tissues, surface radium *via* molds to all three accessible surfaces of the lip, or the implantation of radium needles The latter method is recommended here, based on the experience of the Radiumhemmet, in Stockholm A standard technic has been evolved which is easy of application, has a comparably low percentage of recurrence, and is relatively free from technical difficulties Forssell (40) reported 68 per cent absolute cures in 66 cases, which compares with the 60 to 70 per cent generally reported [Arzt and Fuhs (1), Broders (18), Collins (25), Kennedy (58), Pfahler and Vastine (82), Quick (86), Regaud (90), Steiner (35), Widmann (117)]

TECHNIC

For lesions of the lip (and skin) up to 3 cm in diameter, one treatment should consist of the following (1) local anesthesia, biopsy, (2) insertion of usually six needles with thread attached (each containing 10 mgm of radium element, filter equivalent to 1 mm Pb, length 2 cm, thickness 0.25 cm), placed 0.75 cm apart, for four hours, total dosage would amount to 6 needles \times 10 mgm \times 4 hr = 240 mgm-hr, (3) the needling is facilitated by first inserting a thin, double-edged blade to prepare the bed for the needle

Usually no further treatment to the primary lesion is required This is followed in a few days by progressive inflammation, leading to ulceration at ten days, with re-epithelialization well marked at three weeks after treatment The end-result should be a soft, non-pigmented, smooth scar Any induration raises the suspicion of persistence of the disease, demanding additional—though less intensive—treatment

Variations of the above technic, of course, occur, depending on the size and

thickness of the lesion A second set of weaker needles (3 mgm each) is also used, eight being inserted as a rule On one occasion, the infiltrating lesion being 2 cm in width and depth, the maximum number of 15 needles, each of 10 mgm element, were inserted in two layers, for four hours, giving a total dosage of $15 \times 10 \text{ mgm} \times 4 \text{ hr} = 600 \text{ mgm-hr}$ The end-result was not seen

For lip lesions larger than 3 cm, distant radiation by x-ray or telerradium (the five-gram bomb at 3 cm, giving depth dosage of 2 cm) is preferred Needling of such large lesions involving the entire lower lip gives too great an area of necrosis and ulceration, which may be aggravated by secondary infection, and usually leads to a poorer end-result Massive resection, with plastic repair, has proved effective with such lesions

Lesions of the upper lip, occurring so rarely as to lead some to believe that an immunity of the area exists, may be treated as above Primary healing will result in over 90 per cent of the cases under skilled x-ray, surface or interstitial radium, electrocoagulation or surgical treatment, or any planned combination of these

CANCER LINGUÆ

Here we are dealing with the most common and one of the most malignant tumors of the mouth A frontal plane through the circumvallate papillæ and the seventh tooth of the lower jaw divides the anterior half from the base of the tongue Lesions of the anterior half may be treated by excision, electrocoagulation, radiation, or by a combination of these With excision, less than hemiglossectomy is usually considered unsafe

Radiation here signifies emphatically intratumoral radium Surface radium has no place in the treatment of intra-oral cancer, no matter how heavily filtered (Quick, 87) To give the desired lethal depth dose may result in gross permanent damage on the surface, with painful, unstable radium burn scars External radiation by roentgen rays or telerradium may be used as pre- or post-auxiliary measures, but should not be relied

upon to accomplish more than partial regression of the lingual tumor, regardless of the extent of cross-firing. Intratumoral radium, whether the element or emanation, has found the widest acceptance as the most reliable method of delivering the required epidermicidal dose to all parts of the lingual cancer. Tables have been formulated according to which, by measuring the diameter of the tumor, the amount of radon (in seeds) required to give the desired dose may be ascertained, expressed in erythemas (Martin, Qumby, Pack, 69).

In 1923, Regaud (89), in Strasbourg, presented startling results, namely, 24 cures of at least two years' duration by radium puncture of cancer of the tongue. In his London report, in 1925, 20 of these patients were still alive and free from disease. These results were acclaimed as the best ever reported (Muir, 78). Only one patient had died of recurrence. Subsequent developments of Regaud's technic have led to its present-day wide adoption. He has called attention to the instability and increased radiosensitivity of the cancer cell during mitosis. On the basis of this conviction he has formulated the principle of using small doses (weak needles) of gamma rays only, delivering the epidermicidal dose over a long period of time so as to radiate all the tumor cells in their mitotic phases. His technic, described by Lenz (64) and Muir (78), has varied recently only in the increased emphasis on teleradium as a pre- and post-supplement to the implantation of needles, and as a method of treating neck nodes prophylactically (see Treatment of Cervical Nodes, p. 40).

TECHNIC

(1) A single treatment is given which is usually preceded and followed by external radiation (teleradium). The needles used should be 2.7 and 3.5 cm long, 1.5 mm thick, filtered with 0.5 mm platinum, contain 0.6 to 1.0 mgm element, 1 needle per c.c. tumor tissue, for from six to eight days, usually eight. Total dosage, 1,500-3,500 mgm hr, according to size of lesion. Each needle has a double eye, so that it may be

fixed in the tissue by suture, the other thread is strapped by adhesive tape to the cheek. There should be daily mouth irrigations. A fluid diet must be followed.

This prolonged single treatment must not exceed a certain limit of time, for the growth may become resistant, *i.e.*, retrograde changes in the tissue, obliterative endarteritis, making the tissues susceptible to infection and radionecrosis.

The above method has been adopted with approval by Handley (49), Cade and Evans (33), Harmer and Russell (50 and 51), Lenz and Muir, among others. If the growth has not disappeared in six weeks, Harmer excises the regressive lesion with endothermy.

Berven⁵ and Quick (87) see no special advantage of weak radiation over long periods. Since 1922, at the Radiumhemmet, Berven has given (1) External radiation by teleradium, using the 5 gm bomb at 6 cm, through four circular portals, by cross-firing above and below the mandible, giving from 50 to 100 gram-hours total dosage. After from three to six weeks the reaction has largely subsided. Partial regression of the tumor occurs in 75 per cent and total disappearance in approximately 25 per cent of the cases. (2) The tumor remnant is either destroyed generously by bipolar electrocoagulation, followed by implantation of needles into the tumor base, or the remnant is needled with 10 mgm needles for four hours, as outlined for lip cancer.

Quick (84 and 87) prefers the use of 0.3 mm gold tubes of emanation, preceded by "thorough" external radiation. This cuts down the intensity of the interstitial dosage required. He feels that tubes of less than 1 mc radon do not provide enough gamma radiation per unit. The principle of 1 mc seed per c.c. of tumor tissue is generally followed.

During each intra-oral treatment with radium a suitable shield of lead covered with dental compound should be molded, thereby protecting other parts of the mouth.

It must be remembered that implanta-

⁵ Personal communication.

tion of the tumor bed after excision with the knife or cautery delays healing, often from two to three months

For cancer of the tongue arising on leukoplakia, the best treatment is excision (Lenz, 64) In general, leukoplakia persists at the site of an epithelioma that has been cured by radium, unless radionecrosis destroys this site Saracin (98-*b*) found leukoplakia present in 20 of 30 cases of consecutive (multiple) cancer of the buccal cavity Further, tongue cancer superimposed on a syphilitic tumor bed responds badly to radiation and the prognosis is usually worse (Berven)

Treatment of tumors of the base of the tongue is difficult with all methods The region is inaccessible to effective surgery The nine patients cured for four years in Rieder's (93) series of 82 tongue cases treated surgically, all had lesions of the anterior third of the tongue The remaining 73 cases died within the four-year period

The difficulties of implanting radium needles are also considerable This has led to suggestions of inserting weaker radon seeds—0.5 to 1.0 mgm, with 0.3 mm gold filtration, totaling not more than 10 mgm (Souttar, 106)—through the neck, beneath the ramus and behind the angle of the mandible, with care not to penetrate into the oral cavity because of the danger of rapid spread of infection Cade (33) advises resection of the angle and ascending ramus of the mandible for exposure to insert needles in the base of the tongue and posterior mouth He states that the after-function is good

Láng (63), of Budapest, recommends inserting needles through the neck, above the hyoid bone, into the base of the tongue He first cocaineizes the pharynx and controls the insertion by placing a finger in the pharynx The needles (strength not stated) are left from five to six days If the tumor is extensive, a suprahyoid linear incision is made and the entire extent of the growth is needed By this method he obtained primary healing in five of eight cases of cancer of the base of the tongue Lasting results are not mentioned Needles inserted into the tongue through the mouth should, of

course, be fixed by suture so as to prevent loosening or swallowing of the needle

Regaud, Berven, and Quick stress the importance of thorough external radiation as a preliminary measure The task of pre-operative radiation, as described by Forsell (40), is, besides its direct effect on the tumor tissue, to diminish peri-tumoral infiltration by calling forth a resorption process, and to facilitate radical operation, occasionally changing an inoperable to an operable tumor In addition, it may weaken the virulence of the tumor and thereby lessen the danger of dissemination by surgery

CANCER SUBLINGUÆ

Cancer of the tongue, floor of the mouth, and of the lower jaw often merge into one another by extension The consensus as to treatment of sublingual cancer heavily favors radiation Radical extirpation is difficult Judd and New (27) employed the Kocher operation, *i e*, splitting of the mandible close to the midline and radically dissecting the floor of the mouth and the cervical lymphatics, in six advanced cases, all of which died of recurrence Kuettner obtained 11 per cent cures of sublingual cancer in his series of 266 cases of mouth cancer (Hahn, 47) Eggers (31) removes the primary with the electrocautery, after first ligating the lingual or external carotid artery

Regaud and Berven employ the same technic as separately described for cancer of the tongue Intratumoral radium, heavily filtered, with sub-lethal amounts in the region of the mandible, is advised Danger of bone necrosis is great from the dose necessary Regaud (91) reports 22 per cent cures in 77 cases Berven (5) reports 26 cases, from 1913 to 1925, of which seven were cured and 19 were dead His 11-year report, from 1916 to 1926, showed

FIVE-YEAR CURES

Lingual cancer	32%	} 278 tumors of the mouth with 76 (or 27 per cent) five-year cures
Sublingual	34%	
Mandibular	18%	
Buccal	26%	

Láng reported primary healing in seven of ten cases, by needling both through the oral and submental routes, without mention of end-results

CANCER GINGIVÆ AND MANDIBULÆ

Radiation here offers little. While a few authors advise preliminary application of local surface or interstitial radium (Rose and Phillips, 95), Berven, 5 and 8), these and others favor ultimate resection of the mandible, especially when the bone has been destroyed by irradiation, as is frequently the case (Blair, 11, Quick, 87, Forssell, 41, Regaud, 64, and Simmons, 4). The difficulties of radiologic treatment are great. The periosteum is exceedingly sensitive to radium. The ordinary dose causes necrosis in which cancer may grow rapidly (Berven, 5). Radiated bone becomes osteomyelitic. The sequestration is so slow and painful that early resection of the involved bone is indicated. Berven first applies telerradium pre-operatively, then coagulates the lesion with endothermy, with later resection, as necessary.

When the alveolus is invaded, Rose and Phillips (95) first insert small element needles of from 1 to 2 mgm strength for from seven to ten days, until the "optimum reaction" occurs, *i e*, hyperemia, softness, and white plaques of lymph on the surface. Then the involved section of bone is removed with the drill and Gigli saw so as to leave a bridge of continuity of the mandible.

Cancer arising in the gingiva or alveolar margin of the upper jaw may extend to involve the maxillary antrum. Destruction by electrocoagulation is recommended, followed by packing radium into the wound, if it is extensive. Oehngren (81) employs four tubes, each of 25 mgm, with the heavy filtration equivalent of 3 mm Pb, laid in the wound for from 15 to 20 hours, giving a total dosage of from 1,500 to 2,000 mgm-hr. Oehngren's work is stressed as authoritative in the treatment of maxillo-ethmoidal cancer.

CANCER BUCCÆ

The best results are obtained with lesions of the lip and the cheek. Destruction by

the knife, electrocoagulation, or interstitial radium may be employed, preferably either of the latter two. Pólya (83), with wide experience in plastic surgery of this region, warns that extensive removal of the buccal mucous membrane leads to scar formation, contraction, and inability to open the mouth.

If the lesion is to be radiated, certain points must be kept in mind. The bucca is thin and has poor resorptive powers. It is technically difficult to protect the gums and alveolar process. The danger of overdosage and necrosis is great. It is important to ascertain whether or not the skin over the cheek is fixed. Láng could not cure any of these with interstitial radium. Surface applicators should not be used, for they are difficult to apply and hence are dangerous (Berven, 4). The buccal mucous membrane is very sensitive as compared with the resistant buccal cancer. Perforation of the cheek, with persistent salivary fistula, is a dire complication. Superimposing even the slightest procedure on heavily radiated tissue, especially in this region, may lead to perforation.

As least dangerous, Berven recommends external radiation (telerradium) followed by either electrocoagulation or insertion of radium needles, 1 mgm for each 0.25 c.c. of tumor tissue. If the pterygoid muscles are invaded, with partial fixation of the jaw, Láng inserts needles first into the anterior part of the tumor, and later completes the implantation when partial regression has occurred, affording better exposure.

CANCER PALATI

Cancer of either the hard or soft palate occurs but rarely. The hard palate may be invaded by tonsillar tumors. Destruction by electrocoagulation, followed by radium laid in the wound packed with gauze, would seem the rational approach. Palatal defects may later be compensated by the wearing of a suitable artificial plate.

With cancer of the soft palate, Láng obtained primary healing in three of five cases by using 1 or 2 mgm gold filtered element needles interstitially. Souttar (106), rec-

ognizing the inconvenient access to the palate, feels that it can best be approached from behind the angle of the jaw. This area lies in the plane of the soft palate, hence, the needle can enter any point of the soft palate on the same side without entering the mouth. He advises the use of weak radon seeds, totaling not more than 10 mgm. He has devised a long instrument with a revolving barrel attached, whereby ten or more seeds can be inserted without completely withdrawing the instrument.

CANCER TONSILLÆ

Cancer here is of the most malignant type. Practically no five-year reports have been found. The three-year cure rates range between 4 and 10 per cent [Kuettner (62), 7.7 per cent, Burnam (20), 9.75 per cent in 123 cases], with the sole exception of Berven's recent encouraging results at the Radiumhemmet, Stockholm.

Treatment depends wholly on radiation for what results there are. The region is beyond the reach of effective surgery. The tumors are classified, as we have seen, into the adult, resistant squamous-cell carcinoma, the sensitive transitional cell, and lympho-epitheliomas and sarcoma. At the Radiumhemmet (8), till 1924, x-ray plus surface radium were used in 28 cases. Only 25 per cent had primary healing, and all were dead within three years. Since 1924, the cases have been treated with telerradium (the 5 gm bomb at 6 cm for 100 to 150 gram-hours through several portals), followed by either surface or interstitial radium, or coagulation of the regressed tumor remnant. Eighteen cases were thus treated, up to 1927, with 7 (or 39 per cent) living more than three years. While deductions should be cautious from series of less than a hundred cases, these results are regarded as the best yet reported.

Burnam (20), Berven (6), Cade (23) and others who have employed both methods are convinced that the effects of mass radiation at a distance (telerradium) are very much superior to those obtained by x-ray. These authors regard this as the greatest

recent advance in mouth and pharynx therapy.

Since the disease is so difficult to control, a thorough course of combined radiation should be carried out. Intensive external radiation, preferably by telerradium, should be followed in three to six weeks, with subsidence of the reaction, by interstitial radium. With the adult squamous-cell cancer principal dependence must be placed on the implantation technique. With transitional-cell epithelioma, the combined treatment is best, while with lympho-epithelioma, the intensive telerradiation alone is effective (Burnam). The latter author uses interstitially radon tubes with gold or platinum filter. He uses larger units (2 mgm) and fewer of them. Heavy implantation is frequently followed by sloughs, which are extremely slow in healing and may give discomfort for months. However, if the growth has disappeared these areas heal and the functional result is good.

Untoward reactions to radiation easily occur. The tonsil is surrounded by radio-sensitive normal tissues, leading to injury, pain, and disagreeable symptoms. The salivary glands are injured easily. The periosteum of the mandible and hard palate are very sensitive, and heavy cross-firing can easily destroy large parts of the mandible. Recognizing these hazards, Burnam states, "If radiation is used it should be carried to a dosage beyond that necessary to cause primary regression or disappearance of the tumor." He has seen many patients who have been cross-fired through large portals, front, lateral, and back, followed by intense dryness of the throat, loss of hair, irritation of the skin, with no alteration of the tumor.

Interstitial radium in Harmer and Russell's (51) hands gave palliation but few cures, leading them to the statement that growths in the region of the fauces are almost always incurable. Lang ligates the external carotid artery preventively, then inserts gold-filtered needles (1-2 mgm) through the mouth and from below the mandible, taking great care not to let the point of the needle come onto the mouth.

This latter error led to fatal sepsis in one case. Of five cases so treated, he obtained primary healing in three.

Much better results are seen with radiation of sarcomas of the tonsil. Striking regression usually results from roentgen treatment alone, after the Coutard technic. Berven (9) supplements this with the surface application of radium. He reports 36.5 per cent five-year cures in the unstated number of cases treated from 1916 to 1927.

In brief, we see that x-ray therapy is reserved for the lympho-epithelioma, sarcoma, and lymphosarcoma groups. For the remainder, the combined therapy of teluradium (or x-ray), interstitial radium, and endothermy is preferred. Surface radium is difficult to apply and to maintain in correct position.

TREATMENT OF CERVICAL NODES

Early treatment of the cervical lymphatic areas in every case is imperative, no matter how effective the primary cure. We have seen that, once metastases have developed in the neck nodes, the chance for cure by any treatment is practically lost. While surgery may cure a few such cases, no cures from any form of external irradiation can be expected. In 72 cases with neck metastases, Forssell (40) obtained no cures by radiation.

Prophylactic treatment of the neck areas, therefore, becomes the all-important factor. Years of experience have shown that prophylactic external irradiation is uncertain, and that it should be used only in combination with surgery (Regaud, 90). Berven,⁵ at the Radiumhemmet, administers only a pre-operative dose of teluradium to all cases (50-75 gram-hours total through two portals on each side of the neck), with no attempt to give intense curative dosages.

The majority of radiologists practise the policy of applying external radiation to the neck areas and waiting for further developments (Berven, Cade, Collin, Duffy, Jacoby, Quick, Regaud, Stewart). If nodes develop later, these authors advise dissec-

tion, if the cancer has not invaded the capsule of the nodes to cause fixation (inoperability). Does this mean that sight has been lost of the fact that when metastases have developed the chance for cure is practically lost, whether or not the node capsule is invaded?

Evidence that prophylactic radiation of the neck nodes has reduced the frequency of later metastases is difficult to obtain. Regaud, with an eight-gram bomb recently installed (November, 1934), favors teluradium ever more strongly in the effort to supplant prophylactic dissection of the neck areas. This experimental work is, as it should be, confined to the larger centers for investigation.

To serve the best interests of the patient, however, main dependence must, with few exceptions, be placed on early *en bloc* dissection of the neck areas before the nodes are involved. Theories as to the protective function of the lymph nodes [Janeway (56), Quick (87), Berven (5)] cannot justify a waiting policy, depending completely upon the uncertain effect of external radiation, which must not be so intense as to injure the tissues where later operative attack may be necessary. The penalty of waiting is too great. If the nodes become invaded, the chance of cure is precipitously diminished.

One recognizes the protective function of the axillary nodes in breast cancer, yet the marked reduction in the chance of cure, once the axillary nodes are invaded, makes it imperative that they be removed without delay. Too much importance has been attached to the protection rendered by the cervical lymphatics. Answering the question as to why cancer metastases grow so regularly in the lymph nodes, Murphy (79) suggests that the lymphocyte as it exists in the node is inactive, and is capable of functioning only when it migrates into the tissues, just as the polymorphonuclear leukocyte cannot perform one of its important functions, that of phagocytosis, inside the blood vessels—hence, the growth of cancer in the presence of antagonistic cells.

Small, early lesions of the lip, without

ulceration, deep infiltration or nodes, and of low grade malignancy (Grade I) may be given irradiation to the neck areas after the eradication of the primary, and be controlled by careful follow-up examination. All others should have early dissection of at least the submental, submaxillary, and upper deep cervical region on the same side [Eggers (31), Kennedy (58), Lund and Holton (66)]. If the lesion is in the center of the lip, the question of bilateral dissection comes up. Among the 531 cases reported by Broders (18), 76.26 per cent of those operated upon and that showed no metastases were clinically cured. Kennedy (58), in 246 cases treated by surgery both to the primary and to the neck region, obtained 88 per cent cures in cases with the lesion under 3 cm in diameter and 44 per cent in those over 3 centimeters.

With lesions primary in the tongue, floor of the mouth and mandible, early dissection, after subsidence of the primary reaction, should be carried out wherever feasible, even when palpable nodes are not present [Evans and Cade (33), Fischel (38), Kuettner (62), New and Judd (27), Regaud (91)] until recent adoption of teluradium [Rieder (6), Roux-Berger (97 and 98), Simmons (103)]. Regaud (91), until recent emphasis on teluradium,⁵ advised neck dissection in cancer of the mouth in general, usually three weeks after treatment of the primary lesion. If the nodes showed cancer histologically, then post-operative surface radium on wax molds was applied to the neck areas. Berven⁶ administers pre-operative teluradium, through two portals over the neck areas on each side, at the same time as treatment of the primary. If no nodes are present, he waits until they appear, except in cases of extensive primary lesions. Quick (87) leans most strongly away from surgery, gives external radiation, and exposes and implants radon seeds in nodes as they appear.

Poor general condition, recurrence of the primary lesion, metastasis below the clavicle, fixation to the spinal column, extensive

skin invasion, and tumors of embryonal type are regarded as contraindications to operation.

The only adequate removal is the "block dissection," so named and well described by Crile (26), in 1906. He devised this operation in 1898, after the Halstead breast operation. The technic is essentially unchanged to-day. Removal of the sternomastoid muscle and the internal jugular vein should be decided upon in the individual case, especially where involvement of the nodes seems likely. The procedure is simplified by using the plane of interjugulocarotid cleavage, from below upward, dissecting gently with the finger. Roux-Berger and Tailhefer (98-a) advise resection of the posterior belly of the digastric muscle and the stylohyoid muscle so as to allow free dissection of the jugular vein up to the base of the skull. They state that the most frequent invasion of nodes from tongue cancer occurs in those behind the angle of the jaw. They have done the above in 23 cases without mishap.

During the dissection, Fraser (44) inserts from 30 to 40 mgm of radon seeds under the posterior belly of the digastric muscle, for here the dissection is usually incomplete.

The factors determining the extent of the operative attack are well outlined by Jameson and Dobson (55). Growths on the lateral border of the tongue indicate unilateral bloc dissection, after eradication of the primary. Those of the tip and frenum of the tongue require bilateral dissection, in separate stages. Likewise advanced lesions of the tip, border, and dorsum going over to the alveoli or floor of the mouth, require bilateral dissection. The internal jugular vein should not be sacrificed on both sides. Neck dissection properly carried out should not lead to mutilative disfigurement. Recurrence after adenectomy is low (Roux-Berger and Monod, 98). The experienced technics outlined by Crile (26), Roux-Berger, and Semken are recommended.

With lesions of the cheek, alveolar margin of the upper jaw and palate a more con-

⁵ Observed, November, 1934.

⁶ Personal communication 1934.

servative attitude may be taken, based on dissection of the neck on the same side, especially when the primary cancer is extensive

Lesions of the tonsil and base of the tongue more frequently show an undifferentiated histologic picture, *i e*, transitional cell, lympho-epithelioma, or sarcoma. The neck nodes tend to occur as a diffuse ill-defined chain, as opposed to the more localized groups of adult epidermoid metastases. These are best controlled by external radiation, either x-ray or teluradium (Berven, Quick, Regaud). Burnam, however, recommends removing movable nodes in cancer of the tonsil.

Treatment of inoperable, fixed metastases is indisputably by radiation, both external and by implantation of radon seeds. The exposure and implantation of radon seeds in operable nodes as they become involved, proposed by Quick (82), has found but limited acceptance as a substitute for surgery. At the Radiumhemmet, Stockholm, and L'Institut du Radium, Paris, excision is regarded as the most effective treatment.

PROGNOSIS

Limitations should be placed on the importance of grading of tumors as an index to prognosis. MacCarty (68) lists at least seventeen factors which must be considered, namely, the type, size, and location of the lesion, nodal involvement, fixation, renal and cardiac efficiency, anemia, age, duration, direction of growth, weight loss, degree of cellular differentiation, lymphocytic infiltration, fibrosis, hyalinization, and the extent of destruction produced by treatment. Numerical grading deals with but one of these factors, differentiation.

Stewart (110) points out that grading of tumors is not new. Its principles were recognized by Virchow in his "Scala der Malignitat" and by a host of others since. It has been popularized of late, with the substitution of figures for complicated pathologic descriptions. Broders classification has shown itself to be of value for group prognosis. It is far too little for in-

dividual prognosis, as is seen from the above factors enumerated.

Rieder (93), using Broders' classification in 82 cases of tongue cancer, found no agreement between the clinical results and grading of at least half of the so-called differentiated cases. He states that the subjective element is too great to allow of certain numerical grading. Even with additional data plus the histologic picture, a 30 per cent discrepancy resulted, when compared with the end-results. In these cases recurrence or metastases occurred, although histologically a good result was expected.

SUMMARY

The difficulties attending treatment of intra-oral cancer have been examined. Attempt at comprehensiveness, based on anatomico-pathologic study and a degree of acquaintance with both radiation and surgical treatment of this region, has been made.

CONCLUSIONS

Intra-oral cancer, among the most accessible, remains among the most fatal of malignant diseases.

Since 1910, intra-tumoral radium has played a progressively dominant part in the treatment of cancer of the mouth.

Over 90 per cent of malignant tumors of the mouth are epidermoid carcinomas, mostly of the adult resistant type.

Of the buccal epithelium, the basement cell alone has the power of reproduction and of invasion. All other cell changes represent stages of degeneration.

Epulis, regarded by some as a granuloma, is "semi-malignant."

Leukoplakia is the most important precancerous lesion. All cases of leukoplakia are curable.

Enlarged cervical nodes should be regarded as cancerous. Once cancer invades the cervical nodes the chance for cure is practically lost.

Early diagnosis will improve the results more than any other single factor.

Radium is the treatment of choice of the primary lesion in all cases which have extended beyond the possibility of easy operative removal

Intratumoral radium must be of epidermicidal intensity, whether over a short or long period, to be reliably effective. In this form it is the best caustic ever devised for cancer.

The 1934 technic of the Radiumhemmet, Stockholm, and L'Institute du Radium, Paris, are presented.

What cures there are in cancer of the tonsil have come from radiation, which must be rigorously employed.

In the treatment of the cervical lymphatic areas, irradiation is uncertain. It should be used only in combination with surgery, which should be early and radical. The penalty of waiting until nodes develop is too great.

Grading of tumors is but one of at least seventeen factors in determining individual prognosis. It is of especial value in determining group prognosis.

Better management of the individual case will result from the surgeon and radiologist working together than from either alone.

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ADENOMYOMA OF THE RECTOVAGINAL SEPTUM TREATED WITH RADIOLOGIC METHODS¹

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THIS study is a review of 36 cases of adenomyoma of the rectovaginal septum, in which the patients were referred to the Section on Therapeutic Radiology, at the Mayo Clinic. The first case was observed in 1918, and the last three cases were observed in 1934.

An adenomyoma is a tumor composed of glandular and muscular tissue. Considered from a general standpoint, this type of tumor may be found in many organs of the body, and when so situated, it usually is representative of the structure of the tissue from which it arises.

This consideration deals in part with adenomyomas of the uterus, and specifically with adenomyomas found in the rectovaginal space. Lockyer, in 1913, presented a paper entitled "Adenomyoma in the Recto-uterine and Recto-vaginal Septa," and he accordingly is accredited with having been the first to identify this phase of the disease. Keene and Kimbrough found that the earliest contribution to the subject, which dealt with adenomyomas of the uterus, was the report by Rokitansky, in 1860. In 1896, the work of von Recklinghausen appeared, and, almost simultaneously, Cullen presented his report of similar tumors that were found in the round ligaments. He is accredited with having been the first to demonstrate that the glandular inclusions in adenomyomas are of endometrial origin. Prior to the work of Sampson, in 1921, this disease was considered a pathologic curiosity and, therefore, of little or no clinical significance. His theories may be questioned, but the value of his work is outstanding.

The theories of origin, which have been advanced by many observers, are of interest. However, it is not within the scope of

this presentation to enter at length into this controversy. The wolffian theory, which has been advanced by von Recklinghausen, attributes the source or origin of the glandular elements of adenomyomas to adult remains of the wolffian system. He considered that these masses were "organoid" tumors in which he could trace the component parts of the mesonephron. The presence of these tumors in the pelvis, rectovaginal septum, external genitalia, groin, and distal end of the right round ligament, was considered to be the result of the extension of the gubernaculum ovarii, which originates at the lower pole of the kidney, through the utero-ovarian ligament, and from the uterus to the groin, through the round ligament.

Cullen advanced the mucosal invasion theory because he was able to trace a direct communication between the glandular portion of the tumor and the uterine mucosa. He considered that other tumors, which were similar to those that are found in the uterus, were the result of displaced müllerian rests. Russell is credited with having been the first to report a case in which endometrial tissue was found in the ovary. He assigned its origin to "an aberrant portion of the müllerian duct." Cullen suggested the müllerian rest theory to explain the occurrence of adenomyoma in the right round ligament. The theory is based on the close relationship between the anlage of the ovary and Müller's duct and the possible interchange of cells. Russell said, "It is not hard to conceive that a portion of germinal epithelium which forms the ovary should, at times, attempt to produce structures which its function elsewhere calls upon it to do."

The serosal theory is based on the observations that the endothelial cells of the peritoneum may undergo transformation into cylindric or cuboidal cells, through the

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influence of inflammatory processes, and that the connective tissue in the region of these cellular inclusions undergoes hyperplasia, which may closely resemble the cellular stroma of the uterine mucosa. Meyer is given the credit for demonstrating this theory and describing the pathologic change as a healing process.

The implantation theory of Sampson, which was reported in 1921, rests on the idea that uterine or tubal epithelium may escape through the fallopian tubes into the peritoneal cavity at the time of menstruation, and that when these particles of tissue find lodgment they may penetrate the tissue involved. Sampson has advanced much evidence to support this theory.

These theories are not all-inclusive, however, they stimulated research and discussion, which have advanced our knowledge of this disease. It is necessary to accept the influence of the ovarian hormone on these tumors, as well as their reaction to menstruation and pregnancy. This hormonal feature is very important to the physician who plans to treat this neoplastic disease.

INCIDENCE

The occurrence of adenomyomas (endometriosis) is more common than generally is supposed, and the importance of these tumors evidently has not been recognized. Cullen, in 1908, reported that adenomyoma was present in 83, or 5.7 per cent, of 1,283 cases of fibromyoma of the uterus. In 1919, MacCarty and Blackman reported that adenomyoma was present in 211 of 3,398 cases of fibromyoma of the uterus, an incidence of 6.4 per cent.

Owing to the invasive nature and migratory characteristics of these tumors, many structures of the body may be involved. The following structures have been involved: ovaries, uterus, rectum, sigmoid flexure, round ligaments, broad ligaments, walls of the vagina, inguinal region, external genitalia, walls of the intestine, appendix, bladder, abdominal scars, omentum, fallopian tubes, and peritoneum.

TABLE I—INCIDENCE OF ADENOMYOMA IN VARIOUS SITUATIONS

Situation	Keene and Kimbrough Cases		King Cases	
	No	Per cent	No	Per cent
Rectovaginal septum	6	5.0	52	42.6
Ovary	110 ²	92.4	23	18.9
Umbilicus and ovary	2	1.7	0	
Laparotomy scar	1	0.8	0	
Peritoneum	0		26	21.3
Uterus	0		17	13.9
Tube	0		4	3.3
Total	119	99.9	122	100.0

² Unilateral 63, bilateral 47

TABLE II—INCIDENCE OF ADENOMYOMA ACCORDING TO AGE OF PATIENT

Age of patient, years	Cases	
	No	Per cent
25 to 29	2	5.55
30 to 34	11	30.55
35 to 39	10	27.77
40 to 44	5	13.89
45 to 49	8	22.22
Total	36	99.98

An attempt was made to determine the incidence of adenomyoma of the rectovaginal septum, but neither the reports in the literature nor the material at my disposal lends itself to this estimation. The incidence according to the situation of the involvement, as reported by Keene and Kimbrough, and by King, is given in Table I. In the cases that form the basis of the present study, the patients were referred to the Section of Therapeutic Radiology because of involvement of the rectovaginal space. Therefore, the incidence of involvement of the rectovaginal septum should be rather high in this group of cases, because the situation of the infiltration makes the diagnosis a comparatively simple affair.

Age Incidence—The age incidence is shown in Table II. Since this disease is influenced by the menstrual cycle and apparently develops slowly, these few cases would seem to indicate that the neoplasm requires at least from ten to twelve years for development, and probably much longer in the older age groups. The time of onset is as yet clinically impossible of determination. It also may be inferred

TABLE III—MENSTRUAL HISTORY IN 36 CASES OF ADENOMYOMA

	Cases	
	No	Per cent
Normal and regular	12	33 33
Regular (dysmenorrhea and menorrhagia in five cases)	14	38 88
Irregular	10	27 77
Total	36	99 98

TABLE IV—CHIEF COMPLAINTS IN CASES OF ADENOMYOMA

	Cases	
	No	Per cent
Pain in lower part of abdomen	8	22 2
Pain in inguinal region	1	2 8
Pain in buttock	1	2 8
Pain in epigastrium	1	2 8
Pain in rectum	7	19 4
Dysmenorrhea	2	5 6
Menstrual irregularity	5	13 9
Tumor	5	13 9
Carcinoma	2	5 6
Fatigue	2	5 6
Rectal bleeding	1	2 8
Diarrhea	1	2 8
Total	36	100 2

that the cessation of menstruation reduces the number of instances in which the condition is discovered among elderly women. While these cases are too few to permit definite statements, the trend of the disease is shown rather clearly.

GYNECOLOGIC HISTORY

In the 36 cases that form the basis of this study, the gynecologic history was as follows. Ten, or 27.8 per cent, of the patients were single, and 26, or 72.2 per cent, of the patients were married. Seven of the patients had had one child each, two of these patients had had one or more miscarriages. Six patients had had two children each. Two patients had had three children each, and another patient had had four children and two miscarriages. One patient had had six children. Nine of the patients who were married had never had any children or any miscarriages. Adenomyoma may be a factor in the production of sterility, as it may infiltrate the cervix and fix, or limit the motion of, the fundus. The discharge which it produces also may alter the chemistry of the vaginal secretion.

The menstrual history is of great assistance in establishing the diagnosis, because the symptoms may be associated with or aggravated by the menstrual cycle. The menstrual history in these cases is recorded briefly in Table III. Many of the phenomena of disturbed menstruation depend on the extent and situation of the lesion. The presence or absence of surface ulceration is a factor. The menstrual discomfort is of the acquired type. There is a possibility that this association may have been overlooked in the cases which were seen first.

Vicarious menstruation was noted in nine, or 25 per cent, of the cases. In eight of these cases, there was blood in the stool at the time of menstruation. This establishes the importance of a rectal examination by endoscopic methods in these cases. In one case there was a bloody discharge from the navel.

Dyspareunia was recorded in four of the cases (11 per cent). This feature depends chiefly on the extent of involvement and fixation of the pelvic structures. The incidence may be higher than it appears, as this information seldom is volunteered by the patient.

CHIEF COMPLAINTS

The major chief complaints are recorded in Table IV. Many patients had multiple complaints, some of which were referable to the disease, while others were unrelated to the adenomyoma. An attempt was made to group these complaints according to the importance that the patient placed on them.

In 20 cases (55 per cent), pain was the chief symptom. In eight of these, the pain was situated in the lower part of the abdomen, and in seven, it was situated in the rectum. Seven patients (19.5 per cent) complained of menstrual disturbances. In seven cases (19.5 per cent), the patients complained of a tumor, or of a carcinoma, in these, the diagnosis usually had been made by the attending physician. The chief symptom was related to or modified by menstruation in 20 cases (55.5 per cent).

In 16 cases (44.4 per cent) the history did not reveal any relation between the chief symptom and menstruation. This figure probably is unreliable, as the relation between the chief symptom and menstruation can be established in a very large number of these cases, if this condition is suspected. It may require careful questioning to elicit this relationship. Adenomyoma should be suspected in all cases in which this relationship can be demonstrated.

The duration of the signs and symptoms is recorded in Table V. Evidently, the development of these growths may be considered slow or moderately slow, especially when the size of the neoplasm and the duration of the chief symptom are considered. As a rule, these growths are not large or bulky infiltrations, such as commonly are seen in cases with a lengthy history in which malignant disease is present. This disproportion should also awaken the thought or idea that the disease may be an adenomyoma.

GYNECOLOGIC AND CLINICAL DIAGNOSIS

The diagnosis usually can be made as a result of bimanual pelvic examination and careful inspection of the vaginal mucosa. The infiltration usually is described as a nodular or multinodular mass that is situated in the region of the vaginal *cul de sac*. The mass may extend anteriorly to the posterior wall of the vagina, or laterally to the right or left fornix of the vagina. In cases in which the growth is situated in this region, it becomes attached to, or involves, the neighboring structures, especially the anterior wall of the rectum and the vaginal wall in the region of the *cul de sac*. Tenderness may or may not be present during palpation. The extension laterally may infiltrate the broad ligament and result in a large fixed mass in the pelvis. There may be slight or moderate obstruction of the rectum. In some cases the rectal obstruction may be so severe as to necessitate a colostomy. The ureters may be included in the pelvic mass, and a unilateral or bilateral hydronephrosis may result. In some of the cases, the

TABLE V—DURATION OF SYMPTOMS OF ADENOMYOMA

Years ¹	Cases	
	No	Per cent
Less than 1	12	33.33
1 to 2	10	27.77
2 to 3	5	13.89
3 to 4	2	5.55
4 to 5	1	2.77
5 to 6	3	8.33
8 to 9	2	5.55
9 to 10	1	2.77
Total	36	99.96

¹ Longest duration 9 years, shortest duration 6 weeks

TABLE VI—GYNECOLOGIC AND CLINICAL DIAGNOSIS

Diagnosis	Cases	
	No	Per cent
Adenomyoma	26	72.22
Carcinoma	5	13.89
Tumor	5	13.89
Total	36	100.00

walls of the urinary bladder were involved. The growth may infiltrate the cervix, especially the supravaginal portion, and the posterior wall of the fundus of the uterus. Various physicians have reported involvement of the external genitalia, inguinal region, abdominal scars, and umbilicus. An exploratory laparotomy may reveal the characteristic tumors and dense adhesions of the pelvic structures. Involvement of the ovaries, rectum, rectosigmoid, sigmoid flexure, omentum, broad ligaments, and round ligaments has been reported. In cases in which there is an adhesion of the epithelial tissue which covers these tumors, there is a bluish discoloration of the tumors. The discharge, which occurs in cases in which the tumor is broken or undergoes ulceration, is similar to the menstrual discharge, and its occurrence always has some relation to the menstrual cycle. In 14 of the cases in this series, the tumor was small, in two cases, it was large, and in the rest of the cases, the size of the tumor was not mentioned. In the 14 cases in which the tumors were small, the average size of the growth was 3.6 by 4.2 centimeters. The smallest

TABLE VII—CLASSIFICATION ACCORDING TO CULLEN

	Cases	
	No	Per cent
Group 1	2	5.55
Group 2	11	30.55
Group 3	11	30.55
Group 4	12	33.33
Total	36	99.98

tumor measured 0.5 by 0.5 cm., and the largest tumor measured 5 by 6 centimeters. In 14 cases, the growth was fixed or adherent to adjacent structures. Retroversion of the uterus was noted in ten cases, which was a rather high incidence. In cases in which there are extensive infiltrations, the uterus is intimately associated with the pelvic infiltration, and it is impossible to be certain regarding the size and situation of the fundus of the uterus. The rugæ of the vagina persist, and there may be sessile polypoid masses, or definite pedunculate polyps in the vagina in some cases. The latter feature lends weight to the inflammatory theory of the origin of this neoplastic disease.

The tentative diagnosis, which was made at the time these patients first registered at the Clinic, is given in Table VI. The cautious diagnoses of tumor and of carcinoma were made in the early years of this study. A careful history, palpation, and inspection should reveal the correct diagnosis. Biopsy may be performed to substantiate the diagnosis, especially in cases in which there are denuded or ulcerated lesions in the vaginal *cul de sac*.

PROCTOSCOPIC EXAMINATION

The general physical condition of these patients is very good and no definite undermining of their health was noted. Aside from the usual laboratory tests, no special tests are indicated. The most common special examination which was done was a proctoscopic one. Miles, in 1921, pointed out the significance of this disease entity in the field of proctology. On account of the situation of the infiltration between the rectum and vagina, and because of the likelihood of involvement of the anterior

rectal wall, rectal distress may be the chief symptom.

In 18 cases (50 per cent), a proctoscopic examination was done. This revealed positive findings in 14 cases (77.77 per cent) and negative findings in four (22.22 per cent). The most common proctoscopic finding was an extra-rectal mass, which occurred in 12 cases, and was situated about 10 cm. from the anus, involving chiefly the anterior wall of the rectum. The rectal mucosa may be attached or adherent to the surface of the infiltration, it may bleed easily when touched, or ulceration may be present. The mass may encroach on the lumen of the intestine and produce a mild or severe rectal obstruction. In all but two of the cases in which a diagnosis of a malignant or doubtfully malignant lesion was made by the proctologist, the report was only a description of the findings and was not a proctoscopic diagnosis. Patients who have definite rectal symptoms should be subjected to a proctoscopic examination. It should be a consideration in all cases to rule out the possibility of involvement of the rectum. *The proctologist must be alert to recognize this disease entity.*

CLASSIFICATION OF CASES

Cullen, in 1917, suggested the following classification for a similar group of cases. *Group 1* Small tumor, single or multiple, is relatively free in rectovaginal septum. *Group 2* Tumor is adherent to posterior surface of cervix and anterior surface of rectum. *Group 3* Tumor glues cervix and rectum together, and spreads into one or both broad ligaments, tumor is not fixed. *Group 4* Tumor involves posterior surface of cervix, rectum, and broad ligament. There is a diffuse pelvic mass which is fixed and causes partial obstruction (rectum, ureters).

An attempt was made to classify the 36 cases in this manner, by employing the data contained in the history, surgical cards, and records of special examinations. The results of this classification are shown in Table VII.

GROSS AND MICROSCOPIC PATHOLOGY

Mahle and MacCarty have described the adenomyomas of the rectovaginal septum as follows

"Pathologically, extra-uterine adenomyomas are identical in appearance regardless of where they are found. They differ grossly from adenomyoma of the uterus, in that the cystic areas are larger and the contents darker brown. Grossly, the tumors are solid, fibrous, and of a light gray color. Here and there, white bands extend into the tumor substance, while between these bands are areas, dark brown to almost black, varying in size from the head of a pin to cystic areas 1 cm. or more in diameter.

"Microscopically, the stroma consists of fibrous connective tissue and smooth muscle fibers, the latter in varying amounts. Within the stroma are gland spaces lined with cylindrical epithelium. Some glands are surrounded by a very cellular stroma, the cells of which are regular with round or oval nuclei resting in a very fine reticulum, while other glands are immediately surrounded by smooth muscle or connective tissue. In some portions of the tumor substance there is marked evidence of recent and old hemorrhage. In the latter areas are clumps of endothelial cells filled with old blood pigment, and in one of these areas a typical foreign body giant cell is seen enclosing a mass of blood pigment. The adenomatous portions of these tumors with their cellular stroma are identical with uterine endometrium.

"Clinically, these tumors give no consistent group of symptoms on which an accurate diagnosis can be made. However, their location and slow growth, extending over a period of years, suggest benign tumors. Further, the occasional relation to the time of menstruation, of pain or swelling of the tumor, or less frequently a bloody discharge should be very suggestive of adenomyoma.

"Surgically, adenomyomas, regardless of their remarkable infiltration characteristics, should be differentiated from malignancy. Especially is this true of the tumors in the pelvis, adherent to the sigmoid or the abdominal wall, or other structures. Adenomyomas may be recognized grossly in most cases by the fibrous stroma which contains cystic areas filled with a bloody, dark brown, or serous fluid.

"The pathologist should distinguish adenomyoma from carcinoma by the regularity of gland structure with normal differentiated epithelial cells without mitosis and, in most tumors, by the characteristic stroma surrounding the glands. He should also recognize that they are benign tumors, that they grow by invasion, and do not metastasize.

TREATMENT AND RESULTS

Keene and Kimbrough stressed the acceptance of the fact that the activity and proliferation of these tumors are dependent on ovarian function, and, conversely, that ablation of ovarian function will cause these tumors to atrophy. Therefore, the surgeon and radiotherapist must be guided accordingly in the treatment of this disease. Since the disease affects women who are comparatively young, the problem is not always a simple one, and it usually is wise to err on the side of conservatism.

Adenomyomas which cause rectal pain, bleeding, and backache, can be treated with radium and roentgen rays, but the desired results require a menopausal dose. Graves (4, 5) pointed out that regression does not always occur with cessation of the menstrual cycle, assuming that these patients have passed the bound of this hormone influence. Apparently none of the patients in these cases could be so classed. Sampson and others have demonstrated that these lesions may undergo malignant degeneration. These tumors are composed of endometrial tissue and therefore are subject to malignant change. There was no certain evidence of the malignant phenomena in this series of cases. Although the possibility or probability of malignant change is evidently very small, it must be reckoned with.

The management of the cases seen in the early years of the recognition of this disease entity was "entirely operative." Operation was the first and only method of treatment, and deserves much credit for advancing our knowledge of this "devastating and fatal" disease. Surgical material furnished much valuable information, which shortened the time necessary for a correct diagnosis and the institution of effective therapy. To-day, surgical interference is the treatment of choice in certain forms of this disease, for example, in cases in which there is ovarian involvement. In other cases surgical removal is most difficult, and in some cases it is impossible. One of the characteristics of the disease is to form

firm dense fusion of neighboring structures, which makes their separation difficult, and in some cases impossible

It is not within the scope of this paper to discuss at length the operations which are employed in these cases. However, it is important for the radiotherapist to know what type of surgical procedure was done, in order to outline adequate irradiation therapy

Seventeen of the patients had submitted to some type of pelvic operation for this disease before they came to the Clinic. Eight of these operations could be classed as radical, while nine were conservative. These consisted of local excision, removal of specimen, some type of cautery, and so forth. In one case in which a radical operation had been performed elsewhere, a recto-vaginal fistula had developed shortly after the operation. In 24 of the cases in which operation was performed at the Clinic, some type of conservative procedure was done. In two of the cases, the operation was radical, and in ten cases, the condition was not treated operatively at the Clinic. There was one death in the hospital, caused by peritonitis. An exploratory

involved the rectum, the cervix, and the anterior wall of the rectosigmoid. Separation was considered dangerous, and a loop colostomy was all that was done.

From the standpoint of irradiation therapy, the cases may be classed in two groups: (1) those in which the treatment was directed toward the local infiltration as a primary malignant neoplasm, and (2) those in which the treatment was given to control menstruation, and thus indirectly to influence the neoplastic process. There were 15 cases (41.7 per cent) in which the treatment was direct, and 21 cases (58.3 per cent) in which the treatment was indirect. The patients who comprise the first group were treated early in our experience, which accounts for the relatively large number of cases in this group. The technic of irradiation consisted chiefly of the application of filtered radium, at various distances, to the vaginal surface of the infiltration, with or without supplemental so-called low voltage roentgen therapy through anterior and posterior pelvic fields. In 1926, the first patients were treated with the indirect method. This technic is intended primarily to control

TABLE VIII —TYPE OF TREATMENT AND RESULTS

Type of treatment	Cases	Per cent	Deaths in hospital	Good result	Temporary relief	Failure	Indeterminate
Radium (direct)	6	16.66	1	2	2	0	1
Radium (indirect)	8	22.22	0	5	0	1	2
Radium (direct) and roentgen rays	3	8.33	0	2	1 ⁴	0	0
Radium (indirect) and roentgen rays	9	25.00	0	7	1	0	1
Operation and radium (direct)	2	5.55	0	1	0	1	0
Operation and radium (indirect)	3	8.33	0	2	0	0	1
Operation radium (direct) and roentgen rays	2	5.55	0	1	1	0	0
Operation radium (indirect) and roentgen rays	1	2.77	0	1	0	0	0
Radium (indirect at the Clinic direct elsewhere) and roentgen rays	1	2.77	0	1	0	0	0
Operation only radium treatment refused	1	2.77	0	0	0	0	1
Total	36		1	22	5	2	6

⁴ Died subsequently, cause not known

laparotomy was performed in seven cases. In one of these cases there was one tumor, in another case there were two tumors, and in a third case there were three tumors. In one case there was an extensive infiltrating tumor in the vaginal *cul de sac*, which

menstruation. In some cases, the intra-uterine application of radium, similar to that which is employed in the treatment of menorrhagia with or without fibroids, is used. Radium packs were applied to the vagina. The applicator is the one used in

the treatment of cervical carcinoma (2) In some cases, the preceding treatment is supplemented with the application of radium packs to the abdominal wall, in the right and left ovarian areas, or with a combination of moderate and high voltage roentgen therapy, as employed in the treatment of menorrhagia (1) A rather wide choice of methods is available in treating this disease

The type of treatment which was employed in these cases and the results are shown in Table VIII The incidence of good results in the cases in which the patient was treated by the direct method may be attributed to the fact that the treatment was sufficient to control menstruation With the return of menstruation, the result was listed as temporary relief since the cessation of menstruation is essential to control the disease In two cases in which failure resulted, the patients were treated inadequately One of these was a young woman, aged 25 years, who received an intra-uterine application of 250 millicurie-hours of radium Later, during the periods of temporary amenorrhea, there was some relief, but she continued to have pain with and without menstruation In the second case the radium therapy was given in part and then abandoned A letter from the patient reports that she has had two normal pregnancies and that the growth has disappeared However, she continues to have pain in the rectum

The death, which occurred in the hospital, was a case in which the radium treatment was applied before the operation, therefore, it may be considered an operative death

The indeterminate group is made up of cases in which the patients replied to letters of inquiry but failed to mention their menstrual history As the control of menstruation is the criteria for good results, these reports were considered incomplete They were in the main favorable, and the patients evidently were definitely improved or obtained a good result One patient died four years after the treatment In this case, amenorrhea had been present for

four years, this was followed by vaginal bleeding, which was associated with severe backache The data are incomplete, so the primary cause of death is unknown There was no definite information available in this study of the results of treatment which would indicate that malignant degeneration had occurred in an adenomyoma of the rectovaginal septum, however, it must be kept in mind as a possibility

SUMMARY

In radiotherapy of adenomyoma of the rectovaginal septum, it is necessary to treat ectopic endometrial tissue which has a histologic structure identical with that of the uterine mucosa Therefore, this tissue is influenced by the ovarian hormone

The history and physical findings should indicate the diagnosis Tissue may be removed for biopsy Every infiltrating tumor in the wall of the posterior vaginal *cul de sac* or in a corresponding region in the anterior rectal wall should not be regarded as malignant When the infiltration is atypical, an effort should be made to obtain a satisfactory history, for in the average case the symptoms and signs will be influenced by the menstrual cycle

An effective method of treatment is a therapeutic menopause which is induced with radiation therapy, this is an indirect attack In the management of young patients (before the age of 35 years) who are seen early, the neoplasm may be removed (1) surgically, or the patient may be observed for some time Bimanual pelvic examination should be performed every four to six months to determine any change in the neoplasm This delay should not prove serious as definite malignant degeneration was not proved in any of the cases studied (2) A trial treatment should be considered to determine possible beneficial effect of a temporary amenorrhea for at least six months to one year (3) The last consideration should be the induction of a permanent therapeutic menopause with radiation

In the cases in which the lesion is advanced, there is no choice The induction

of a therapeutic menopause with radiation is recommended because it favorably influences this destructive neoplastic process. In the cases in which there is rather severe intestinal obstruction a colostomy may be considered, but it should not be performed until the pelvic infiltration has been reduced by indirect irradiation, because it is possible to overcome this serious complication. Mild catharsis, low enemas, and a diet which has little or no residue should be prescribed for a time following the radiation therapy.

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A COMPARISON PHOTOMETER AND ITS USE IN DETERMINING THE DISTRIBUTION OF RADIATION IN A PHANTOM¹

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A COMBINATION of the ionization and photographic methods was used in determining the distribution of roentgen radiation in a rice phantom. The relative intensities in a central beam of radiation were determined with a small ionization chamber. Other points of equal relative intensity in a cross-sectional area containing the central beam were determined by the use of photographic film. To

stant source of illumination. Generally the lamp current is kept constant by the use of a constant wattage transformer or by manual adjustment of a rheostat. The photometer described here was made independent of fluctuations in the intensity of the lamp by the use of two photo-electric cells.

The cells, which were taken from photographic light meters, are similar to the

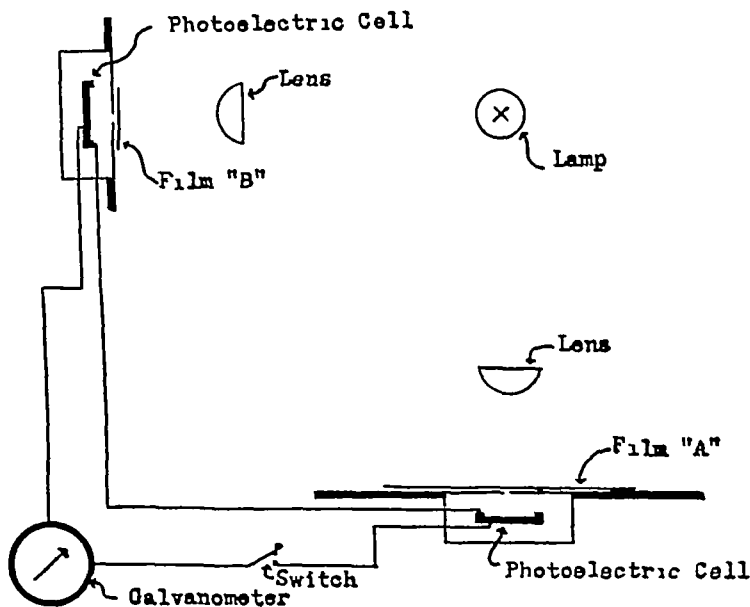


Fig 1 Comparison photometer for determining isodensity lines on film

determine very small areas of equal density on the photographic film it was necessary to use a photometer. The photometer which was built for this work can be used for any photometric work for which the desired data can be obtained by matching the transparencies of two similar objects.

THE PHOTOMETER

One of the difficulties encountered in photometric work is the obtaining of a con-

stant source of illumination. Generally the lamp current is kept constant by the use of a constant wattage transformer or by manual adjustment of a rheostat. The photometer described here was made independent of fluctuations in the intensity of the lamp by the use of two photo-electric cells. Each cell is enclosed in a box, so that the only light which falls on the sensitive surfaces enters through small apertures from 1 to 2 mm in diameter. The boxes containing the cells are so mounted on a frame that the apertures are equidistant from an ordinary electric light bulb (Fig 1). Lenses from small pocket flashlights are so mounted that a part of the image of the filament of the lamp is focused on the apertures. The two cells, a galvanometer, and a switch are connected in series so that the potentials

¹ Submitted for publication in December 1934

generated in the two cells oppose each other

No current will flow through the galvanometer when the potentials generated in the two cells are equal. The two potentials will be equal when the cells are equally illuminated. Equal illumination of the two cells can be obtained by adjustment of the light-absorbing materials in front of the two apertures, and the cells will continue to be equally illuminated regardless of fluctuations in the intensity of the light emitted by the lamp.

The instrument as described has been entirely satisfactory for the work for which it has been used, however, its sensitivity and accuracy could be increased by the use of a better lens system and a smaller filament lamp.

DISTRIBUTION OF RADIATION IN A PHANTOM

The intensity in the central beam of radiation in a rice phantom is determined at several depths with a small ionization chamber. From these measurements a graph is drawn, so that the intensity in the central beam of radiation in the phantom can be determined for all depths.

Process film, which has a slow emulsion with a high degree of contrast, is placed between two thin pieces of cardboard bound together around the edges with strips of black gummed paper. The film in its cardboard holder is then placed perpendicularly in the phantom so that it passes through the center of the field to be irradiated. The film is exposed for from 1 to 20 seconds, depending on the intensity of the radiation and the part of the film to be used, and is then carefully developed. A long exposure is necessary to produce a perceptible darkening near the bottom of a film, but, since a long exposure causes the top of the film to be too dark for accurate

measurements, it is desirable to expose two or three films for different lengths of time.

From the graph constructed from the ionization measurements, definite values for the relative intensity of the radiation in the phantom can be assigned to the various degrees of density in the midline of the film. Lines of equal density on both sides of the midline are determined by the use of the photometer just described. The film is placed in the position of film "A" in Figure 1. Film "B," a strip of film similar to "A," is used for adjusting the photometer for any desired density in the midline of film "A."

Except for variations in density caused by unequal development, by variations in the thickness of the emulsion of the film, and by the variation in sensitivity of the film to radiation of different qualities, the isodensity lines represent isointensity lines of the radiation in the cross-section of the phantom in which the film was exposed. The positions of the lines traced from films exposed and developed at different times have been found to be very nearly the same. This indicates that variations in density caused by unequal development can be made quite small if reasonable care is used in the development of the films, and that the variations in thickness of the emulsion do not produce appreciable errors. The variation of sensitivity of the film to radiation of different qualities is not an important factor because of the small variations in the quality of the radiation which occur in regions of similar radiation intensity.

Sets of isointensity charts for convenient use can be made by drawing the lines on sheets of white paper, photographing the drawing, and making positive prints on film.

THE EFFECT OF HARD ROENTGEN RAYS AND GAMMA RAYS OF RADIUM¹

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ONE of the principal points of contention in modern radiobiology is the question as to whether in the domain of roentgen and gamma rays the effect is dependent on the wave length, or, in other words, whether by equal quantities of absorbed energy different wave lengths have a different effect

For the rays mostly used in therapy emitted at 50 K V without filter to 200 K V with 2 mm copper filter, it is generally admitted that there is no marked difference in effect, but especially in respect of the extremely short waves—shorter than 0.1 \AA —our knowledge is still somewhat incomplete and there are great controversies between various authors

The literature, extensive regarding rays emitted at a tension below 200 K V, is comparatively scanty for the shorter wave lengths. I shall deal with the literature in broad outline only, completeness not being attainable within the scope of this work, I shall chiefly confine myself to the publications concerning the above-mentioned domain of short waves with which I have met during late years. Among the supporters of the idea of equal effect by the same ionization are

Holthusen and collaborators, who have principally experimented on *Ascaris* eggs and on the human skin,

Wood, who has made experiments with inoculations of tumor,

Arntzen and Krebs, irradiating seeds of plants,

Alberti, investigating cornea epithelium of salamanders,

Jacobi (lethal dose for mice),

Fricke, Petersen, and Morse (chemical and colloidal reactions),

Rothstein (trypsin reaction),

Piepenborn (lymph glands),
Vierheller and Saralegui (seeds),
Packard (*Drosophila* eggs),
Glocker and his collaborators (chemical and biological experiments),
Schubert (chick embryo),
Groedel and Schneider (yeast and paramecium),
Simon (*Drosophila* eggs),
Regaud (testicles),
Hess, Grebe and Martius, Sievert, Klein and Gaertner, all of whom have examined the reaction of the human skin

A smaller but still important number of researchers hold the opinion that soft rays have a stronger effect, several of them having investigated the reaction of the skin. Among these are numbered

Wintz and Rump, Glasser and his collaborators, Jona, Stahel, Murdock and Simon, whilst many have made use of other objects

Strangeways and Hopwood (tissue-cultures),

Crowther (protozoa),

Russ and Scott (tumor),

Gunsett, Ancel, and Spack (lentils),

Schugt (castration of mice),

Holweck and Lacassagne (bacteria, yeast, and protozoa)

Adherents of the opinion that hard rays have a greater effect are much fewer in number. I may mention among others Bolaffio, Reinhard, and Zuppinger, working in the field of biology as well as of chemistry. There are also researchers who believe that there is no definite linear dependency of the effect on the wave length, but that special wave lengths are particularly effective (Dognon and Failla)

Apart from these opinions concerning the quantitative proportions, a few other authors believe a qualitative different action of different wave lengths to be demon-

¹ Read before the Fourth International Congress of Radiology, Zurich, July, 1934

strable, e g, Vohwinkel, who examined germinating lentils. Moreover, some authors admit a so-called "differential action," by which they understand the alternation of the proportions of sensitivity of different tissues when using other qualities. Thus Russ and Scott describe the diminution of the ratio

lethal effect on tumor

permanent complete depilation of the skin (rat)

with decreasing wave length. They found that both effects required a greater dose of hard rays, but the relation alters in favor of the tumor dose, consequently the hard rays act in a measure more electively on tumor tissue. Though this opinion has met with opposition from several sides, some account will have to be taken of it, especially since Failla and his co-workers support a similar idea in their recent researches.

This summary shows that there is by no means unanimity, and though the majority of researchers think that by equal ionization or equal absorbed energy, respectively, no varying effect of different wave lengths is to be proved, we might state that other conceptions find numerous prominent supporters. I wish to observe that more or less critical comment is possible upon most of the researches, while much work is already obsolete. Moreover, the number of experiments in the field of radiation with wave lengths below 0.1 \AA is still very small. All these considerations have encouraged me to make a contribution to the solution of this important problem.

In the first place I used roentgen rays produced at 200 K V constant potential (Stabiltvolt Tuto apparatus) filtered by $1.5 \text{ mm Ag} + 2 \text{ mm Cu} + 0.5 \text{ mm Al}$, so that a narrow spectral range of from 0.06 to 0.12 \AA with the maximum intensity at 0.08 \AA

and an average wave length at 0.08 \AA is obtained. The spectrum was photographed with a Seemann spectrograph. The silver filter was chosen to eliminate the Wolfram lines and surrounding wave lengths, whilst the copper filter absorbed the silver radiation and the aluminium filtered away the copper rays. The firm of Philips, of Eindhoven, allowed me to work in their laboratory with roentgen rays produced at 360 K V (apparatus according to the Witka principle), with Philips Metalix tube filtered by the wall of the tube ($3 \text{ mm chrome steel} + 2 \text{ mm tin} + 1 \text{ mm Cu} + 2 \text{ mm Al}$). The spectrum of this radiation was not photographed. The quality of radiation was determined by the half value layer in lead which proved to be 0.65 millimeter. Lastly the effect of γ -rays of radium, filtered by $0.5 \text{ mm Fe} + 1 \text{ mm Pb}$, was examined. For comparative purposes I used x-rays emitted at from 100 to 110 K V filtered by 0.5 mm or $1 \text{ mm Cu} + 1 \text{ mm Al}$, taking the effect of this as the unit, and admitting that below 200 K V no appreciable differences in effect were noticeable.

MEASUREMENTS

In order to determine the quality of the radiations, I used the method of the half value layer in copper or lead, and for some radiations the spectrophysical method. Both methods are sufficiently well known so that I need not enlarge upon them and can refer to Table I.

For intensity or quantity measurements, respectively, a large Siemens dosimeter was employed, which was standardized by a self-made standard chamber built according to the principles of Küstner. On comparing this standard chamber with the apparatus of the Phys. Techn. Reichsan-

TABLE I

Voltage	Filter	Spectrum in \AA	γ Average in \AA	Half value layer in mm
100 K V	$0.5 \text{ Cu to } 1 \text{ Cu}$	$0.12-0.4$	0.22 or 0.2	0.41 or 0.55 Cu
200 K V	$1.5 \text{ Ag} + 2 \text{ Cu} + 0.5 \text{ Al}$	$0.06-0.12$	0.08	3.2 Cu
360 K V	$3 \text{ chrome-iron} + 2 \text{ Sn} + 1 \text{ Cu} + 2 \text{ Al}$	$0.034-$	0.055	4.6 Cu (0.65 Pb)
Radium	$0.5 \text{ Fe} + 1 \text{ Pb}$	$0.0057-0.035$		

stalt at Berlin it was found to agree within some percentage

The dimensions of the cylindrical ionization chamber were 32×24 centimeters. The wall is put on high tension and the collector electrode, connected with an electrometer, consists of a eccentrically placed carbon rod. The scale of the Siemens dosimeter appeared to be quite right for the 100 K V roentgen rays, but for the 200 K V roentgen rays the apparatus was too sensitive, so that a correction of 12.5 per cent was necessary. For the 360 K V I was not able to build a standard ionization chamber. The scale of the Siemens dosimeter, wanting already a correction of 12.5 per cent at 200 K V, was supposed to indicate at 360 K V, 20 per cent above the exact figure. Neither was I able to perform standardizing measurements for γ -rays of radium. For these measurements I used the Siemens dosimeter with an arbitrary correction of 35 per cent, chosen in connection with the above-mentioned deviation of the scale at 200 K V.

Since for the γ -ray measurements a special method, differing from the universal ones, was used, I shall describe my procedure. At the time of the commencement of these researches, there was great uncertainty in the matter of γ -ray dosage. Even nowadays the results of the experiments are far from identical, nevertheless, during recent years interesting work has been done on the subject of radium dosimetry. As in the meantime I had to find out my own way to experiment, I chose an approximate solution based on the following ideas.

To begin with, I wish to report that for biological experiments, I used a radium applicator in the shape of a small table, the top of which consisted of lead 1 mm in thickness, with 1 cm wooden legs. Upon this table-top fourteen small tubes, of 10 mgr radium each, were placed in such a way that the intensity on the basis in a central region of about 2.5 cm diameter was homogeneous, which was controlled photometrically. (See Figure 1, page 60.) According to the law of squares, the intensity upon the base can be calculated, pro-

vided the number of r equaling 1 mgr/cm be known. Table II shows the numbers as stated by a few writers.

TABLE II

	Number of r corresponding to 1 mgr hr/cm
Jona	6.5
Stahel	7.5
Neeff	2.8
Glasser and Mantz	7.4
Failla	2.2
Mayneord	8.7
	Average 5.85

According to later investigations this average number is on the low side, but may be taken fairly low in our case, as the γ -ray sources in the tubes are not point-shaped, so that the accepted distances represent minimum values. The discrepancy in the numbers of the different authors may be partly explained in this manner. Moreover, the greater path followed through the lead by the slanting line of the rays is not taken into account. This correction, however, effective in the same direction, would be but slight. Thus, taking the average 5.8 r, one arrives at the following approximate calculation.

For the tubes A and A₁

$$\frac{2 \times 30 \times 5.8}{1 + (1.7)^2} = 88 \text{ r per hour}$$

the tubes C and C₁

$$\frac{2 \times 30 \times 5.8}{1 + 1} = 173 \text{ r per hour}$$

the tubes D and D₁

$$\frac{2 \times 10 \times 5.8}{1 + (0.3)^2} = 114 \text{ r per hour}$$

For the whole

$$\begin{aligned} \text{applicator} \quad 375 \text{ r per hour} &= \\ &= 6 \text{ r per minute} \end{aligned}$$

(See Figure 2, page 61, and Figure 3, page 62.)

In order to obtain an idea of this intensity for myself, I proceeded as follows. In a $15 \times 10 \times 5$ cm case built of little leaden blocks, I introduced the ionization chamber of the Siemens dosimeter. At a distance of 7 cm from this chamber there was on each side a γ -ray source with 70 mgr of radium. (See Figure 4, page 63.)

The chamber was covered by a wooden layer 1 cm thick, and between this wood and the chamber I placed a photographic

intensity of the table-shaped applicator. For this purpose we exposed a piece of the same film to this applicator for some seconds

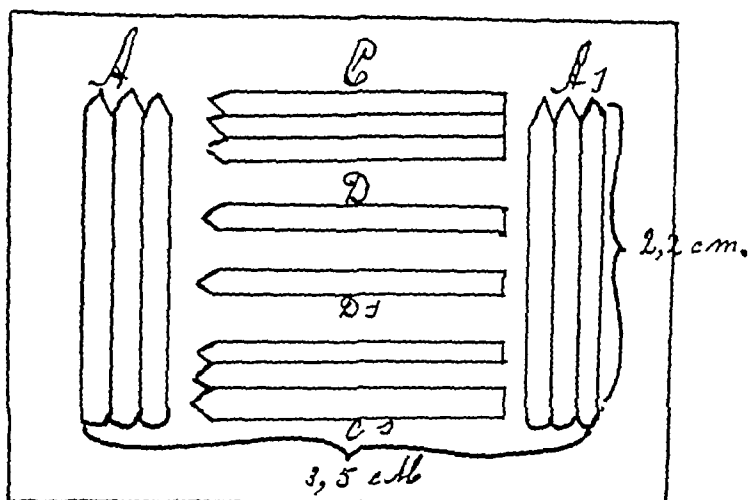


Fig 1

film on each side. By sheltering the electrometer and conductor tubes of the dosimeter with 15 cm of lead, leakage, if any, by radiation was excluded, as was proved by controlling experiments.

The blocks of wood served to avoid the so-called "*Schatteneffekt*," described by Holthusen and Haman. They explain this effect in the following manner: If a metal, *in casu* the lead filter, be irradiated with γ -rays, the secondary β -rays are emitted, especially in a forward direction and, accordingly, they will not decrease with the square of the distance. A much-too-high dose would be measured in that case. If, however, these β -rays are screened off, which is done in our case by the wooden blocks, then this source of error will be neutralized. It is true, the wooden blocks will emit γ -rays again, but their intensity will be parallel to the intensity of γ -rays on that spot. Thus I obtained a blackening of the photographic film, while during the exposure a certain discharge of the electrometer was observed. By switching off a capacity, this electrometer was so sensitive that one could easily read some r . In this manner a certain proportion was found between blackening and ionization. This proportion may be used to calculate the

and then we ascertained the blackening, which can be converted into r by means of the proportion found.

From Table III the results of such an experiment will be seen. (The correction for the developmental fog has been already applied.)

TABLE III

	Film No	Exposure in seconds	Blackening
Direct irradiation with table-shaped applicator with 140 mgr radium	1	20	0.42
Irradiation with radium at 7 cm	2	360	0.38
	3	360	0.41
			Average 0.40

The blackening of Films 2 and 3 can be arrived at with an exposure of 19 seconds according to the table. In these 360 seconds the electrometer had run 36 scale divisions, 7 of which must be ascribed to leakage of its own. These 29 divisions corresponded to 1.9 r . So 1.9 r produced a blackening attained in 19 seconds by means of the table-shaped applicator, consequently this applicator gives 6 r per minute, a num-

ber agreeing remarkably well with the calculated intensity. Admitting a correction of 35 per cent for wave length dependency,

I would formulate the following conditions for an ideal biological test-object

(1) The object must be radiosensitive

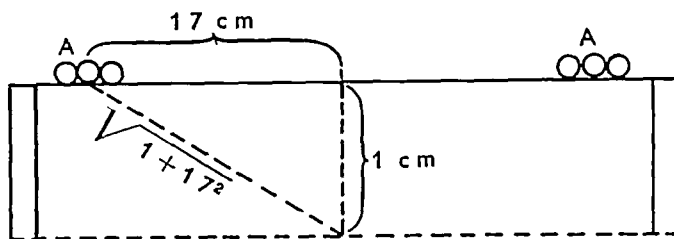


Fig 2

we should arrive at 4.5 r per minute. From these numbers we can at the same time get an idea of the number of r corresponding with 1 milligram-hour/centimeter. 140 mgr at 7 cm distance gives in 6 min 1.9 r, that is, 1 mgr at 1 cm in one hour.

$$\frac{1.9 \times 49 \times 10}{140} = 6.65 \text{ r}$$

If, however, we have to make the same correction for wave length dependency, we get 5 r, which corresponds fairly to the average value stated in literature.

As to the above-mentioned results, we must consider that the radiation source in this case is not point-shaped, and though at this great distance of 7 cm no important correction will be necessary, our number will represent a minimum value. In this way, I have succeeded in a measure in expressing the intensities and dosage of γ -rays in roentgens.

MATERIAL

On account of the possibility of the differential effect dealt with in the literature, I have not restricted myself to the investigation of one reaction, but have included several objects in my research. The number of biological, chemical and other objects already used for experiments is legion. My brief mention of the literature gives but a slight idea of it.

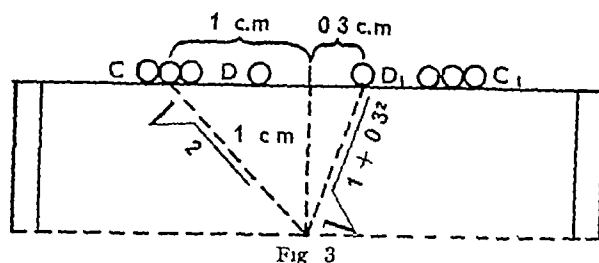
The choice seems to be ample enough, yet if higher demands be made on the test-objects, it becomes much more restricted. Referring to the publication of Zuppinger,

- (2) The results will have to be easily determined (the criterion must leave no doubt).
- (3) The reaction must be fairly exact, in other words, a difference in reaction must be seen at slight differences in dosage.
- (4) A comparatively large number of test-objects must be available.
- (5) The material must be homogeneous in respect to genotypical purity and state of development.
- (6) The reaction must be constant.
- (7) External conditions must not have too high an influence on the reaction. It is almost impossible to keep all the conditions exactly constant, especially when experimenting for a long time.
- (8) Experimental varieties must be easily possible.
- (9) The objects must be obtainable independent of place or season.
- (10) Objects well studied biologically are preferable.
- (11) Biological and experimental techniques must not be too intricate.
- (12) On radiotechnical considerations the object ought to be of small size.

In connection with these requirements, the eggs of *Drosophila*, as also the human skin, are well suited. As for the human skin, this object does not comply with the twelfth condition, so that scattering and absorption proportions of different qualities of radiations and sometimes even with different individuals, will possibly give difficulties.

Further, I investigated some chemical reactions, as, for instance, the alternation of the oxidation-reduction potential of qui-

lasts about eight days, in which a length of from 0.5 to 1 cm is reached. After that, each larva envelops itself in an armor of



none and methylene blue under the influence of radiation and the blackening of the photographic film. Eventually I studied the alteration of the oxidation-reduction potential of human serum by irradiation.

EXPERIMENTS WITH *Drosophila* EGGS

Technics—There are numerous stems originating from the *Drosophila melanogaster* "wild." I chose "Black 12," and cultivated it by mass breeding. For this purpose a number of pairs were put in a cylindrical glass on the bottom of which was a layer of a food-mixture consisting of agar, banana, and yeast. Later, I preferred a mixture of agar, treacle, and refined cornmeal. The bottle was closed by a plug of cottonwool, without splits, since the flies always creep into them. By rotating the bottle obliquely, before the banana-agar coagulated, the wall of the bottle becomes covered by a thin layer of the food, on which the flies by preference lay their eggs.

These eggs, some tenths of a millimeter long, have a skin of chitine surrounded by dried follicle cells, which can still be recognized on their surface as small hexagons. They possess two tiny horns, and at one end a small canal, through which the spermatozoid can enter the egg. Under normal conditions the eggs hatch at room temperature in about 36 hours, some within 24 hours, others in two or three days. The born larvæ, at first very small, grow in the culture by eating yeast and by absorbing liquid. This growth, depending in rapidity on temperature and other circumstances,

chitin. After ten days there appears out of this so-called pupa an adult fly, which is sexually mature within three or four days. The size of the fly is determined by the size of the pupa, depending upon the size of the larva, which is partly fixed by outward circumstances. The flies live about fifty days and can produce some hundreds of eggs. They thrive best at a constant temperature of about 21° C.

In order to collect eggs for my experiments, I proceeded as follows. Some pieces of paraffined paper, provided with little squares of 1 cm drawn with a lead pencil, were moistened, stuck against the wall of a cylindrical bottle, and smeared over with the above feeding-mixture by means of a little brush. After the mixture had congealed and the superfluous food and moisture removed, one or more colonies of flies were put into the "lay-house" by shaking. I left the flies in the "lay-house" for from half an hour to two hours, according to the number of flies and the zeal with which they laid their eggs. Afterwards I shook them into a second "lay-house" or into their "dwelling-house," as the circumstances demanded.

It is possible to make the flies lay eggs for several days at a stretch, provided care be taken that there is always fresh, sweet-smelling food in the "lay-house."

In this connection I will describe some psychological peculiarities. Every ten days we used to give the flies a new "dwelling-house." Gradually, however, it turned out that, when the little insects just had a new place of abode, they were very little in-

clined to deposit their eggs in the "lay-house" We, therefore, left them a little longer in their houses, hoping to compel

provided the slips with little squares, in this way it is possible to count the eggs with a very fair degree of accuracy

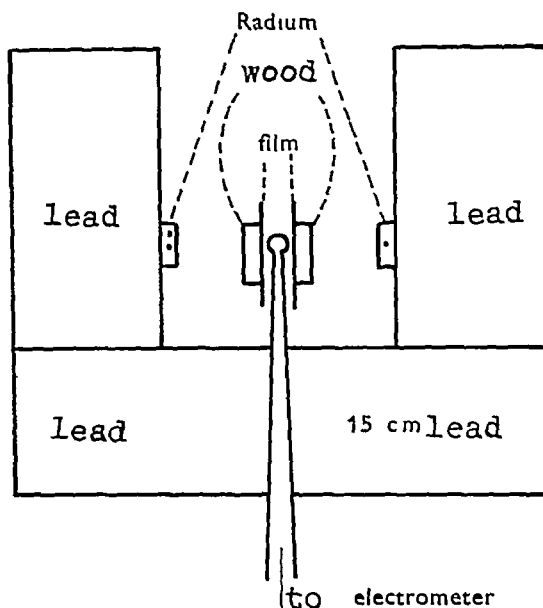


Fig 4

them in this way to lay all their eggs in the desired place. But in that case other factors must be taken into account. For instance, the number of eggs produced is dependent on the quality of the food, so that the flies of older cultures, the food of which becomes insufficient and unsavory, lay but few eggs. In addition to this, the flies then keep their eggs in the uterus for a long time, consequently, when they lay them, the larvæ are born immediately or within a few hours in a great percentage. Such a variety renders the eggs far from fit for our experiments, for which it is of the highest importance to have eggs of a definite age and in not too advanced a phase of development, individuals of different age being differently sensitive. Moreover, it is known that the flies lay their eggs best when it is dark.

After overcoming all difficulties and having collected on our slips of paper a sufficient number of eggs, varying from some tens to some hundreds, we can start our experiment. First of all, we counted the eggs, and it is for this very reason that we

The slips were immediately laid in a Petri dish, and the dish was placed upon a black paper. The white eggs contrast clearly with the black paper, as a rule, I took a strong light, in order to be able to observe the eggs better. The counting was performed with the aid of a binocular microscope. Very often, especially at first, the counting was done by two persons. Thereupon the Petri dishes, on which were labels giving date and age of the eggs, kind of flies, and nature of the experiment, were covered. Moreover, wet wads of cotton-wool were laid inside for the purpose of preventing the agar and eggs from drying up. As soon as we started the experiment we could take such a paper and irradiate it.

For the irradiation we constructed a little wooden frame with a window of celluloid (washed film) which we moistened slightly lest the eggs should dry up during the irradiation. This window, fixed in a stand, could then be brought into any desired position.

After the irradiation the slips of paper were laid again in the Petri dish and kept

at room temperature. Then we counted the number of larvæ hatched after about 24, 48, and 72 hours, and later on occasion-

the biological variety of the eggs accounts for these varying results. However, by making a great many experiments, an aver-

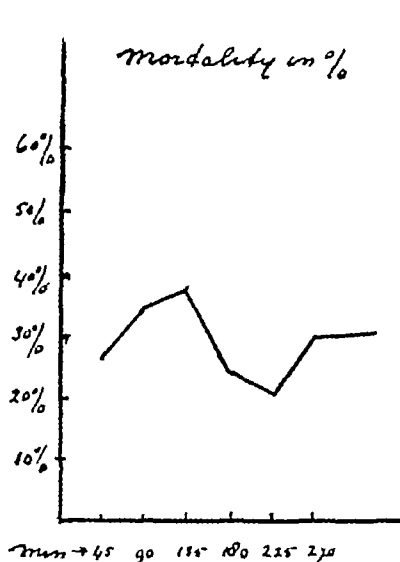


Fig 5

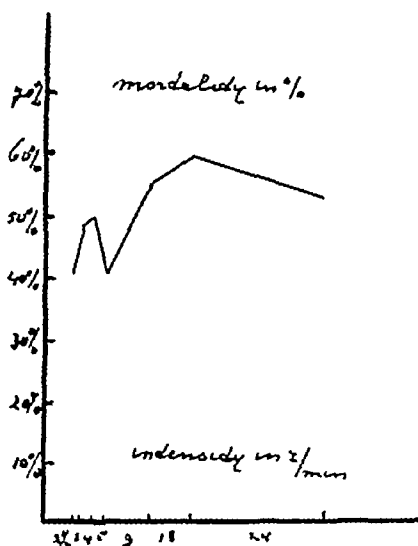


Fig 6

ally after 96 hours, by means of a binocular microscope, and these were removed with a fine pair of tweezers. The number of non-hatched eggs, after correction for spontaneous mortality, showed the rate of mortality due to irradiation. The *Drosophila* eggs are highly radiosensitive, and the spontaneous mortality is very slight—Packard stated 3 per cent on an average, we found about 12.5 per cent. This mortality depends on the dose, for instance, when using increasing doses, all the eggs do not die at the same point, there is even a gradual transition, which we can represent by a S-shaped curve.

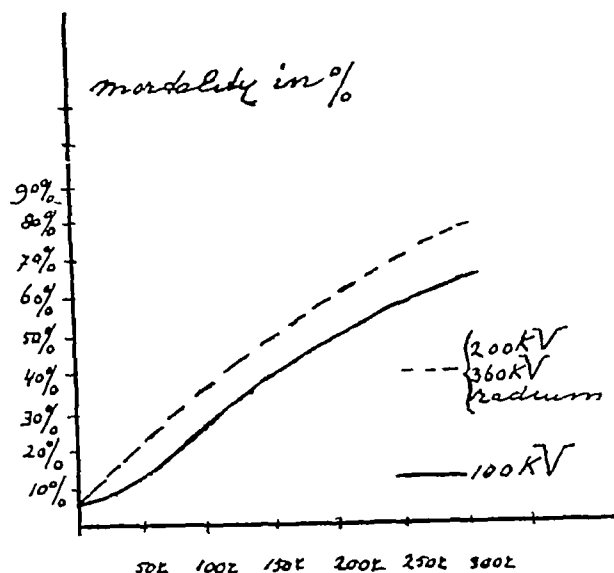
It turns out that there is a small threshold dose, whereas a mortality of 100 per cent can be obtained only when taking a very high dose. In the many experiments I made there were always numerous deviating results, in evident contrast to those of some other research workers, who found very constant rates of mortality for any one dose. Some recently published researches have confirmed my statement. It is obvious that it is not possible to place a high value on one experiment. In my opinion,

age could be calculated which always suited the curve.

Ascertaining the figures of mortality, we counted the eggs hatched daily, mostly on three, sometimes on four, successive days. The eggs hatched within 24 hours—sometimes a few minutes or hours after they are laid—have, in our opinion and in that of other writers, been kept too long in the uterus, and are therefore too old for the experiments. They are no longer highly sensitive in these advanced phases of development. Consequently, for our final results we shall have to take this factor into account, and accordingly subtract these eggs from the total number, before calculating our percentage of mortality. The eggs hatched on the second and third days are the eggs not seriously damaged. The proportion of the number of eggs hatched on the second day to the number of the third day, is, however, partly determined by outward circumstances (for instance, differences in temperature), and so it will be essential not to neglect the hatching of the eggs on the third day, unless the eggs are kept in a thermostat exactly at

constant temperature (18° C) The correction for the eggs which are too old and less sensitive may take place only if the eggs

are remarkably diminished by the correction of the eggs hatched within the first 24 hours



are kept at not too high a temperature, as otherwise many eggs which are not too old would hatch within 24 hours. On the fourth day we removed all agar from the slips of paper in order to discover the larvæ hidden deep in the agar, in this way checking the former counts.

TABLE IV —EXAMPLE OF THE INFLUENCE OF TEMPERATURE ON RAPIDITY OF HATCHING

	Kept at 23° C	Kept at 16° C
Total number	42	35
Hatched after 1 day	24	8
	18	27
2 days	13	18
	5	9
3 days	2	4
	3	5

At the same time, in studying the material it appeared that the eggs first laid on a certain day had better not be used for experiments, since these eggs are often somewhat older on an average than those of the next lay, which may cause some irregularity in the results. In my experiments this proved to be insignificant, but it is wiser to avoid it. At any rate, such irregularities

Often it is not possible to perform the experiments at the same time, so that the portions irradiated with different qualities had to wait more or less long, and therefore showed different stages of development, especially as the early stages of the development show a startling rapidity. The question arose as to whether errors might yet have slipped in, owing to this difference in age. To answer this question we irradiated with the different qualities in reversed order, without finding any noticeable difference in the results.

TABLE V

	Dose	Low K.V irr first mortality in %	High K.V irr first mortality in %
High K.V (200 K.V, 1.5 mm Ag + 0.2 mm Cu + 0.5 mm Al)	50 r	27½	36
	100 r	37	56
	150 r	58	76
	200 r	76½	83
	300 r	76	89
Low K.V (100 K.V 0.5 mm Cu)	50 r	27½	20
	100 r	28	42
	150 r	48	64
	200 r	63½	76½

The results in this table neutralize each other, from the upper half the conclusion

would be justified that the eggs first irradiated are the more sensitive, while from the lower half of the table the reverse con-

Since I nearly always carried out my experiments between forty-five minutes and two hours after the lay, I am of the opinion

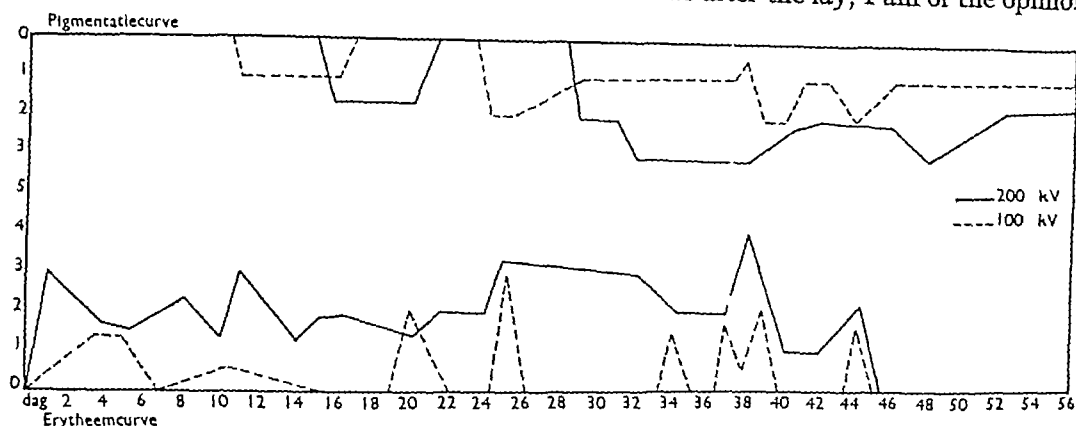


Fig 8

clusion might be drawn. This is, of course, connected with the question as to whether or not it matters how long the eggs were laid before their irradiation. It may happen that, owing to practical difficulties, the eggs cannot be irradiated immediately. Therefore, I made a series of experiments whereby separate portions of eggs were irradiated at regular intervals.

TABLE VI—MORTALITY BY 100 r AT 180 K V, 0.5 MM CU

Time after Taking Eggs Out of Lay-house	No Eggs Not Hatched Total No	Mortality in %
15 min	497/1603	27½
30 min	262/864	30
45 min	438/1609	27½
60 min	301/1115	27
75 min	560/1574	35½
90 min	484/1407	34½
105 min	775/1856	41½
120 min	256/759	35½
135 min	626/1693	37
150 min	387/1021	37½
165 min	518/1746	30
180 min	204/810	25
195 min	516/1854	28
210 min	213/805	27
225 min	406/2063	20½
240 min	192/755	25
255 min	373/1359	27
270 min	345/1155	30
285 min	421/1376	30½

In Table VI and in Figure 5, the results are shown from which we see, as stated by Packard, that the eggs are the most sensitive about two hours after they are laid.

that I did not make any great errors. Still, one may profit by these experiments to limit deviations.

Another question arising is, whether difference of intensity can influence the effects. It is known, and especially emphasized in modern literature, that a definite dose given within a short space of time, *i.e.*, with a high intensity, produces a stronger effect than one with low intensity. However, the limits beyond which this phenomenon appears are not quite determined, and, in my opinion, will differ with various objects.

To solve this question in the matter of *Drosophila* eggs, I also made experiments, the results of which are recorded in Table VII and Figure 6.

The numbers are not wholly convincing, but with the exception of a single figure, which may always be expected in biological tests made during a long period, we can state that under three to four r per minute the same dose becomes less active. In view of this experience, I worked as much as possible with radiations of equal intensity.

The chief part of the research was executed in such a way that I obtained a mortality curve for each type of radiation by exposing portions of eggs separately to different doses. As a rule we used doses of 50 r, 100 r, 150 r, 200 r, 300 r.

Table VIII states the tot:

eggs irradiated with the suitable dosage. No correction has been made for the wave length dependency of the dosimeter at 360 K V and radium, but it is made for the deduction necessary for the old eggs.

Now, making the correction for the wave length dependency at 360 K V and γ -rays of radium, we arrive at the following figures (Table IX and Figure 7).

The figures for the higher tensions and for radium fall along one line, which is on a somewhat higher level than the curve for 100 K V. These experiments leave the impression that shorter wave lengths have a somewhat greater effect than long wave lengths.

EXPERIMENTS ON ERYTHEMA OF THE HUMAN SKIN

The human skin has an undulating reaction, often with several tops. In this reaction, too, the time-factor plays a rôle, so that it is advisable to irradiate with equal intensities. Owing to technical and practical difficulties, I did not make any observations with radiation of 360 K V, only comparing the other investigated three types of radiation regarding the erythema dose. I distinguished five degrees of reaction: degree (1) vague, (2) light pink, (3) pink, (4) red, (5) dark red.

In these experiments the pigmentation

TABLE VII

Time for 150 r	1 1/4'	2 1/2'	5 75'	11 46'	16'	31'	39'	45'	59'
Intensity	100 r/min	60 r/min	24 r/min	13 r/min	9 r/min	5 r/min	4 r/min	3 r/min	2.5 r/min
Mortality on total	852 1805	1154 2022	837 1679	791 1351	1041 1872	761 1960	1101 2200	885 1862	1496 3642
Percentage	47	56	50	58	55	39	50	47.5	41

TABLE VIII

	50 r Total Mort %	100 r Total Mort %	150 r Total Mort %	200 r Total Mort %	300 r Total Mort %
100 K V 0.5 Cu	3020-807-27	2791-867-31	4551-2427-53 1/2	3319-2270-68	3077-2539-82
200 K V, 1.5 Ag + 0.2 Cu + 0.5 Al	3367-972-29	3111-1286-41	4908-3197-65	7505-6051-80 1/2	7588-5984-79
360 K V 2 Sn + 1 Cu + 1 Al	890-264-30	3332-1158-35	3500-1821-52	3831-2520-66	250 r 3520-2435-69

Radium

180 r Total Mort %	360 r Total Mort %	540 r Total Mort %	900 r Total Mort %
2168-1216-56	2736-2209-81	2163-1834-84	1243-1184-95

TABLE IX

Dose int	100 K V	200 K V	360 K V	Radium
40			890-264-30	
50	3020-807-27	3367-972-29		
80			3332-1158-35	
100	2791-867-31	3111-1286-41		
120			3500-1821-52	
135				2168-1216-56
150	4551-2427-53 1/2	4908-3197-65		
160			3831-2520-66	
200	3319-2270-68	7505-6051-80 1/2	3520-2435-69	
270				2736-2209-81
300	3077-2539-82	7588-5984-79		
405				2163-1834-84
675				1243-1184-95

which appeared somewhat later was duly marked, three degrees were noted (1) vague, (2) light brown, (3) dark brown

of the erythema and pigmentation, one could fix the difference at 20 per cent. The erythema waves last, in all, for about six

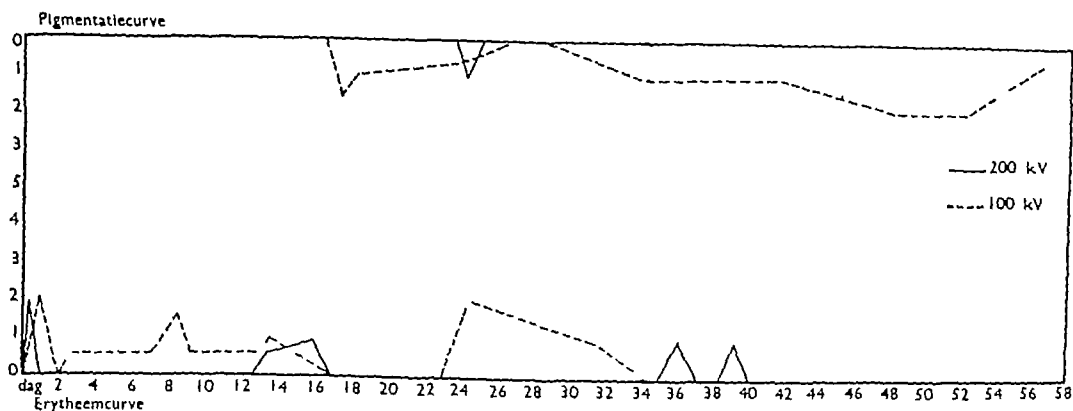


Fig 9

From preliminary tests it appeared to me that I could show a difference in dosage of 12.5 per cent, while I ascertained at the same time that within not too long exposure times a difference of intensity of one to two had no distinct influence on the reaction, so that I could experiment within wider limits. I exposed the skin of one patient to at least two types of radiation practically simultaneously. When experimenting, I paid special attention to the erythema curves, which are the easiest to analyze, and chiefly founded my conclusions on them. The curves below represent the results.

Case 1 Man, 55 years of age, good general condition. On the fore side of the left thigh a field 8×8 cm was irradiated with 500 r (100 K V, filter, 0.5 mm Cu). On the fore side of the right thigh a field 8×8 cm was irradiated with 500 r (200 K V, filter, 1.5 mm Ag + 0.2 mm Cu + 0.5 mm Al). During irradiation the dose was controlled continuously. Irradiation of the two fields was done in one performance.

Observing this patient (Fig 8), a noticeably stronger and more lasting reaction was to be seen after irradiation at 200 K V. Here the tops of the curve of 200 K V are much higher (Fig 8). If one had to estimate the difference in dose from the grade

weeks. In strong reactions the pigmentation remains for months.

Case 2 Woman, about 60 years of age, moderate general condition. On the right groin a field 8×8 cm was irradiated with 500 r (100 K V, filter, 0.5 mm Cu). On the left groin a field 8×8 cm was irradiated with 500 r (200 K V, filter 1.5 mm Ag + 0.2 mm Cu + 0.5 mm Al). During irradiation the dose was controlled continuously. Irradiation of the two fields was done in one performance.

Observing this patient (Fig 9), who received the same dose as Case 1, we note a very much slighter reaction following both irradiations, with a somewhat stronger erythema and a slightly darker pigmentation at 100 K V, 0.5 mm Cu filtration.

Case 3 Man, 40 years of age, rather bad general condition. On the fore side of the right thigh a field 8×8 cm was irradiated with 600 r (100 K V, filter, 0.5 mm Cu + 3 mm Al). On the fore side of the left thigh a field 8×8 cm was irradiated with 600 r (200 K V, filter, 1.5 mm Ag + 0.2 mm Cu + 0.5 mm Al).

This patient (Fig 10) was irradiated with a somewhat higher dose, as the reactions of the skin of the last patient were on the whole so slight that the determination of the grade of intensity was difficult. Though the reaction has not been observed for a

long time, as the patient left the hospital, it is still quite possible to compare the intensity of the reaction, as the rather high

primary reaction (*frühreaktion*) is stronger at 100 K V. The main reaction is, on the contrary, somewhat more intense at 200

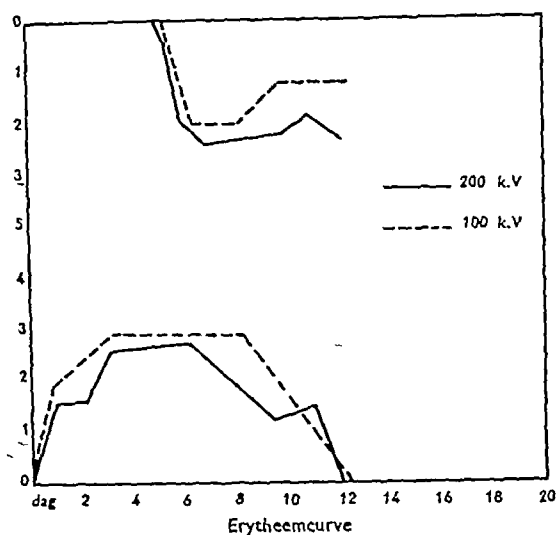


Fig 10

dose had caused a very distinct erythema and pigmentation. Here, too, one notices a small difference in favor of the long waves.

Case 4. Man, 30 years of age, bad general condition. The fore side of the right thigh was irradiated with 600 r (100 K V, filter, 0.5 mm Cu). The fore side of the left thigh was irradiated with 600 r (200 K V, filter, 1.5 mm Ag + 0.2 mm Cu + 0.5 mm Al). Here the reactions were nearly equal, but slightly stronger at the higher kilovoltage (Fig 11).

Case 5. Man, 70 years of age, rather good general condition. The right groin region was irradiated with 600 r (100 K V, filter, 0.5 mm Cu). The left groin region was irradiated with 600 r (200 K V, filter, 1.5 mm Ag + 0.2 mm Cu + 0.5 mm Al). This patient (Fig 12) showed a nearly equal reaction for both qualities, but somewhat stronger at 100 K V.

Case 6 (Fig 13). Woman, 60 years of age, in rather bad general condition. The fore side of the right thigh was irradiated with 600 r (100 K V, filter, 0.5 mm Cu). The fore side of the left thigh was irradiated with 600 r (200 K V, filter, 1.5 mm Ag + 0.2 mm Cu + 0.5 mm Al). The so-called

K V, so that we might conclude a practically equal reaction of a slightly different type.

Case 7 (Fig 14). Woman, 50 years of age, in rather bad general condition. The fore side of the right thigh was irradiated with 600 r (100 K V, filter, 0.5 mm Cu). The fore side of the left thigh was irradiated with 600 r (200 K V, filter, 1.5 mm Ag + 0.2 mm Cu + 0.5 mm Al). The primary reaction, though very slight, is the same at the two types of rays. The secondary erythema reaction is somewhat stronger at 100 K V, but the pigmentation is more marked at the higher kilovoltage. Still, one can conclude that both reactions are practically equal.

Case 8 (Fig 15). Man, 45 years of age, in rather bad general condition. The fore side of the left thigh was irradiated for 165 minutes with 140 mgr of radium on a table-shaped applicator. Not far from this area a field 8 × 8 cm was irradiated with 600 r (100 K V, filter, 0.5 mm Cu, for 100 minutes). The first wave of the radium reaction is much stronger than the wave of the roentgen reaction. The second wave does not show an important difference. (It

was impossible to continue the observation, as the patient left the hospital) This reaction agreed with more than 600 r, that

conclude that the radium applicator gives more than 3.6 r per minute

These erythema tests suggest that the

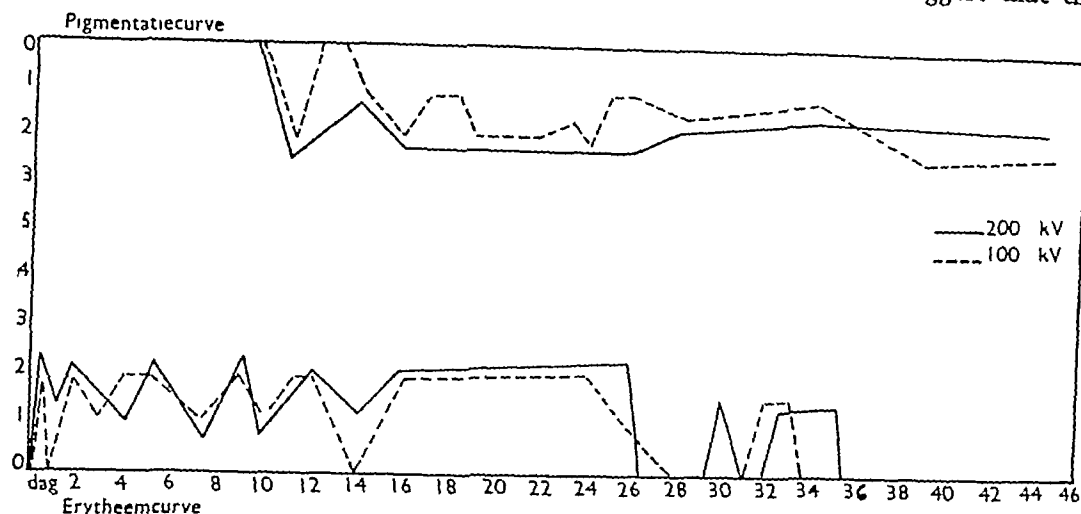


Fig 11

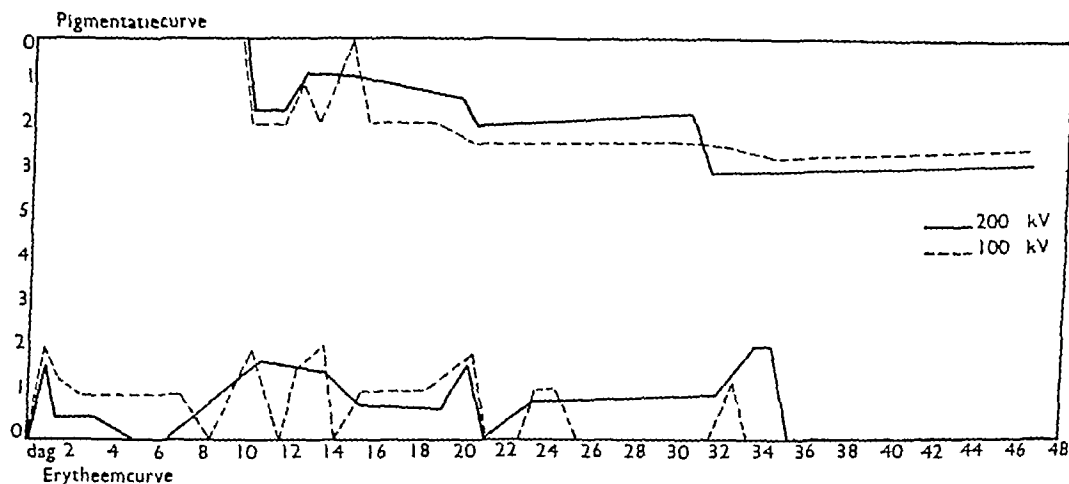


Fig 12

means that the intensity of our radium applicator was more than 3.6 r per minute

Case 9 (Fig 16) Woman, 60 years of age, in rather bad general condition This case was irradiated under the same conditions as the last patient

Here, too, one can see a distinctly stronger radium reaction in the first wave as well as in the second wave The pigmentation caused by the radium applicator is stronger, too Remarkable are the many little erythema waves Here, also, one can

biological effect is proportionate to the ionization power of the rays The radium erythema seems to be less intensive than the roentgen reactions, but then we must not forget that this radium applicator (the small table with 140 milligrams) homogeneously irradiates only a very small surface, as also that the depth dose is very slight The effect on the deeper tissues and vessels will no doubt be of some moment for the appearance of an erythema, so that it is rather remarkable that, in spite of the small

depth dose, the erythema produced by our applicator corresponds so well to the dose, as calculated by us

diation of certain solutions of chemicals By the oxidation reduction potential of a certain solution we understand the tension

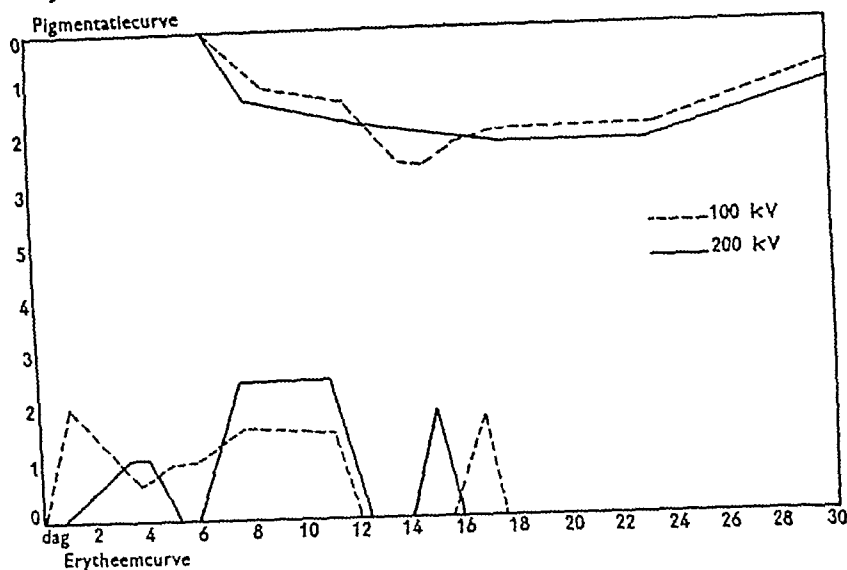


Fig 13

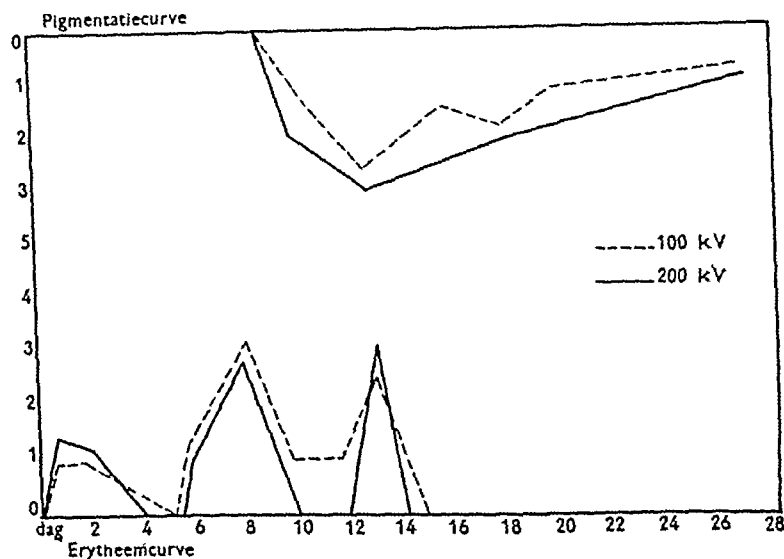


Fig 14

CHEMICAL EXPERIMENTS

In making these chemical experiments I had, from various technical and practical considerations, to restrict myself to the investigation of two types of radiation, namely, 100 and 200 K V. Assisted by Dr Waterman, who has largely experimented on this subject, I examined the change in the oxidation reduction potential by irra-

which is measured by dipping an electrode of a precious metal (for example, platinum or gold) into this fluid, taking care that the hydrogen ion concentration (P_H) is kept constant. This potential is usually measured in comparison with a hydrogen electrode or a half-element of well-known potential, as the calomel electrode. That this potential is connected with reduction and oxidation processes will be clear when we

consider that, in modern chemistry, we understand by oxidation and reduction loss or increase of negative charge (electrons) of

We followed the technical method of these workers. A narrow funnel-shaped glass vessel is closed at the bottom by an

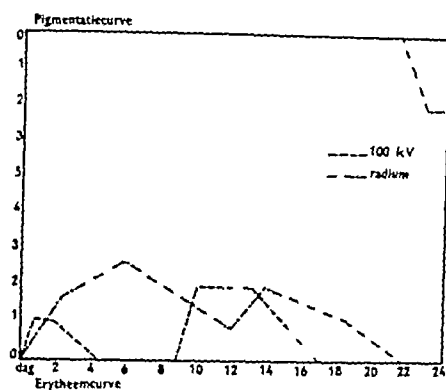


Fig 15

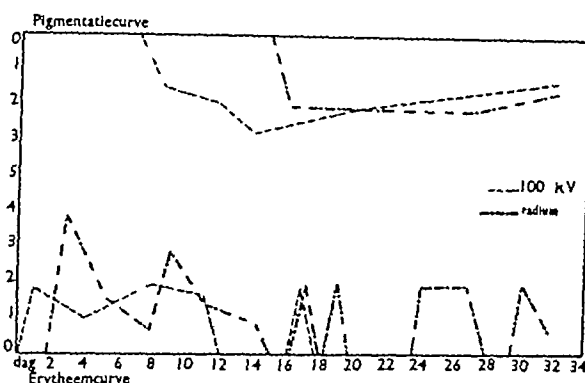


Fig 16

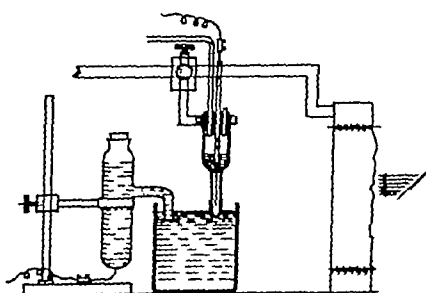


Fig 17

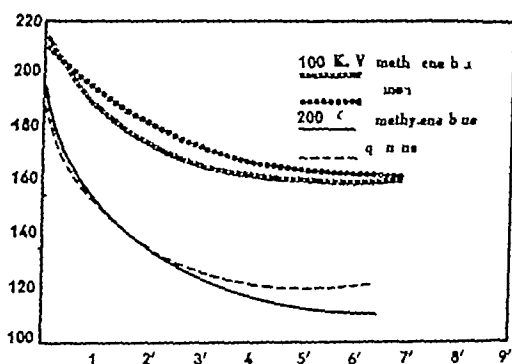


Fig 19

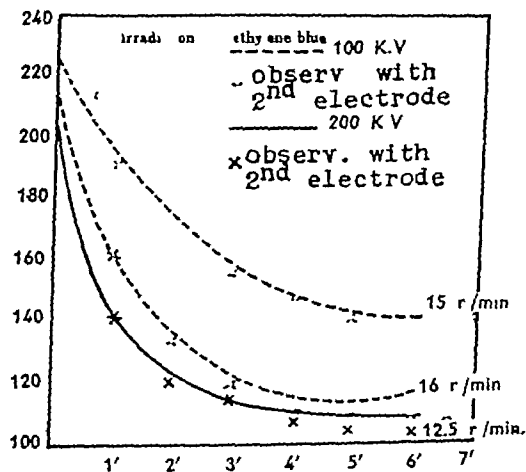


Fig 18

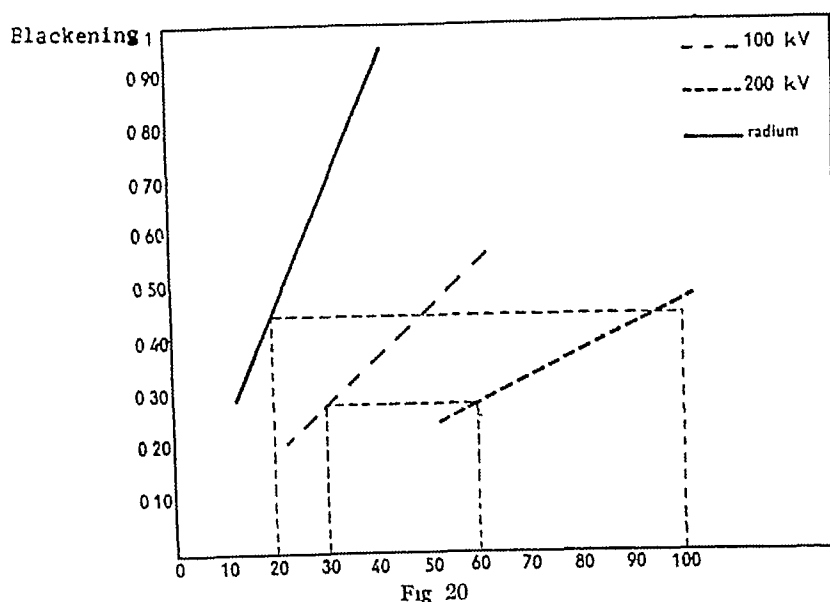
an atom. So oxidation must result in a rise, reduction in a fall, of potential. This tension, called redox-potential, can be strongly influenced by irradiation (Waterman and Limburg).

agar KCl stopper. The fluid to be tested is poured into the tube, and the electrode is fixed in it through a rubber stopper perforated in three places (Fig 17). Two of these openings serve for letting pure nitrogen pass, so that the oxygen of the air cannot have any share in the reaction.

The electrode is connected by a long conducting-wire with a potentiometer placed outside the roentgen room, the bottom side of the tube dips in a Petri dish with 3 N KCl. The same Petri dish communicates with the calomel electrode, which is in connection with the potentiometer, so that *via* this meter the chain is closed and the redox-potential can be read on this instrument. Next I tested (1) methylene blue, which was converted into leuco-methylene blue, (2) quinone, which can be reduced into hydro-quinone. Ex-

amples of the action of both types of radiation are illustrated by the curves below (Fig 18)

and I that of the light transmitted, the blackening $Z = \log \frac{I_0}{I}$ In this connec-



For Curve 18 I used a solution of methylene blue 1/20,000, 100 K V roentgen rays and 200 K V roentgen rays

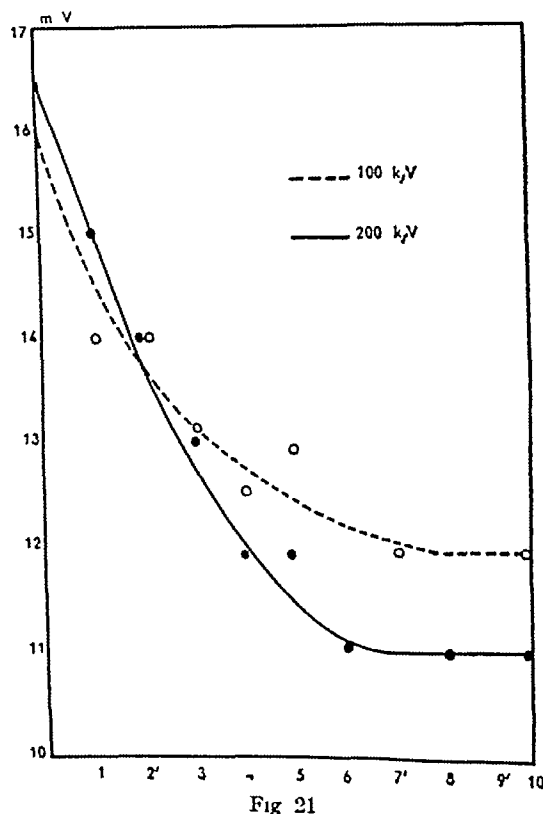
For the curves of Figure 19 I used a solution of methylene blue of 1/20,000 and phosphate buffer of P_H 6.8 and a quinone solution of 1/50,000 in phosphate buffer of P_H 6.6 The intensity of the irradiation of 100 K V was 17 r a minute, of 200 K V, 18 r a minute

From this test, supported by other similar experiments, I came to the conclusion that in this physico-chemical reaction we have to see a difference in favor of hard rays, as revealed by a more rapid fall of the potential (more sloping curves) and in a greater fall, whereby the equilibrium attained is lower

Summarizing the above results, we find in this physico-chemical reaction a difference in effect of about 25 per cent in favor of hard rays

PHOTOGRAPHIC MEASUREMENTS

The blackening of a photographic plate is defined as follows I_0 being the intensity of a bundle of light which falls on a plate



tion we speak of "Blackening 1," if the blackened plate transmits only a tenth of the light, while "Blackening 2" indicates

that no more than 1 per cent is transmitted Z is a function of the intensity of the incident rays and the time of exposure, thus, in general, $Z = f(I t)$ According to Schwarzschild, $Z = f(I t^p)$ in case of visible light, in which p is smaller than 1. As regards roentgen rays, Bouwers has proved that p is almost equal to 1, the same statement was proved by Stoel and myself as to γ -rays. Here the formula of Bunsen-Roscoe, $I t = C$, holds good. These formulas, of course, can be applied only to rays of equal quality, with respect to rays of diverse wave lengths, absorption plays a great rôle, so that an equal number of r of different quality will no doubt produce a different blackening.

Bouwers and van der Tuuk note certain numbers (Table X) for a special kind of film under definite conditions of development.

TABLE X—NUMBER OF r REQUIRED FOR
 $z = 0.5$

Tension in K.V.	Filter		
	1 mm Pb + 1 mm Cu + 1 mm Al	1 mm Cu + 1 mm Al	1 mm Al
190	0.120	0.052	0.026
180	0.100	0.048	0.024
160	0.080	0.040	0.020
140	0.065	0.030	0.018
120	0.050	0.028	0.018
100	0.040	0.021	0.017
80	0.030	0.018	0.016

These differences found experimentally may be explained by the fact that by increasing penetrating power the absorption in the film decreases relatively far more than in the air of the ionization chamber. Such is self-evident, considering that in this spectral range the real absorption in the film still plays a great rôle. This true absorption is dependent on λ^3 , whereas in the air the absorption is caused by scattering, the latter being practically independent of wave length. In absolute sense, the numbers are dependent on the kind of film (sensitivity), and on the developmental conditions.

And what about these relations in regard to our types of radiation? To answer this

question I compared the blackenings obtained with 100 K V and 200 K V.

TABLE XI

Used Dufonofilm, standard developer
Blackenings were measured with a stufometer

Type of Radiation	Exposure Time in Seconds	Blackening after Subtraction of Control
100 K V 0.5 Cu 3 ma focal distance 2 meters	30	0.27
	40	0.33
	50	0.44
200 K.V 1.5 Ag + 0.2 Cu + 0.5 Al 3 ma, focal distance 1 meter	60	0.29
	80	0.39
	100	0.46

Converting the numbers in Table XI into curves, we see that the blackening obtained in 60 seconds at 200 K V is equal to that of 30 seconds at 100 K V. It appeared from ionization measurements that 30 seconds at 100 K V correspond to 0.08 r , whereas in 60 seconds at 200 K V we got 0.48 r , in other words, \approx six times as many r are wanted for the same blackening. (See Table X the numbers marked correspond to our type of radiation.)

Since the radiation emitted at 100 K V, 0.5 Cu has an average wave length of about 0.2 Å, and radiation produced at 200 K V has an average wave length of 0.08 Å, it would be expected, if we had to do only with the absorption that the number of r for blackening at 200 K V would be $\left(\frac{0.2}{0.08}\right)^3 = 15$ times as high as at 100 K V.

That we did not find such a high factor can be ascribed to the fact that, in using these very hard rays, the scattering, especially in the gelatine and the celluloid of the film, is noticeable.

For the photographic experiments with radium, I used our table-shaped applicator. On the strength of our measurement described before, we assumed that the intensity of the γ -rays from this source amounted to about 5 r per minute.

Exposure of 20 seconds produced a blackening of

0.43

Exposure of 40 seconds produced a blackening of 0.95

Thus, in 20 seconds exposure with our radium applicator we get the same blackening as in 100 seconds exposure at 200 K V, the latter corresponding to 0.8 r. Our radium applicator emits in 20 seconds a dose of 1.7 r, so that the γ -rays appear to have half the blackening capacity at a similar number of r. That in spite of the great difference in wave length this proportion is not greater, can be explained by the phenomenon that scattering prevails in cases of very short wave lengths and real absorption sinks into the background.

Summary—The blackening of photographic films by roentgen and radium rays is not proportional to the dose of rays measured by ionization. The harder the rays, the smaller the blackening capacity.

SEROLOGICAL EXPERIMENTS

Many research workers have been engaged on the changes in blood serum after irradiation. In general, serum *in vitro* was irradiated, but others investigated the blood of irradiated humans or animals. All kinds of determinations were made, as, for instance, observations on the albumen composition, cholesterol content, fermentative and bactericidal qualities, and acid-base equilibrium. In short, nearly all possibilities were looked into. It is a pity that the observations of many research workers contradict one another, and it fre-

In connection with the work of Dr Waterman, and with his assistance, I performed observations of the redox-potential of human serum. Dr Waterman demonstrated that carcinomatous serum has a high redox-potential, and can be strongly influenced by irradiation, in contrast with serum of sufferers from other chronic diseases, and of normal persons, whose sera are very constant. Accordingly, carcinomatous serum was irradiated with 100 K V and 200 K V, at an equal intensity of 16 r per minute. One of our observations—all furnishing similar results—is elucidated in the curve shown in Figure 21.

Judging from these observations, I was able to state a somewhat stronger effect of the harder rays, represented by a greater and more rapid declination of the curve.

SUMMARY

A comparative investigation was carried out with

1. Roentgen rays emitted at 100 K V, filter of 0.5 mm Cu
2. Roentgen rays emitted at 200 K V, filter of 1.5 mm Ag + 0.2 mm Cu + 0.5 mm Al
3. Roentgen rays emitted at 360 K V, filter of 3 mm chrome iron + 2 mm Sn + 1 mm Cu + 2 mm Al
4. Gamma rays from radium, filter of 0.5 mm Fe + 1 mm Pb

Theoretical and experimental dosimetric comparisons were made with the following phenomena as indicators

TABLE XII

Object	Material	Effect	100 K.V	200 K V	360 K V	Radium
Siemens Dosimeter carbon-walled chamber	physical	ionization	1	1.125	1.20(?) ²	1.35 (?)
<i>Drosophila</i> eggs	biological	death	1	1.24	1.24(?)	1(?)
Human skin	biological	erythema	1	≈ 1		≈ 1(?)
Oxidation reduction potential (quinone, methylene blue)	chemical	lowering of potential	1	1.3		
Photographic film	chemical	blackening	1	0.16 ¹	..	
Oxidation reduction potential of serum	seriological	lowering of potential	1	> 1		0.08 ¹ (?)

¹ These results refer to equal incident energy.

² The mark of interrogation indicates that the results were partly obtained by reasoning and have not been completely established by experiment.

quently occurs that but scant attention is paid to dosimetric and qualitative differences of the rays

1. Mortality of *Drosophila* eggs
2. Erythema of the human skin
3. Blackening of the photographic film

- 4 Oxidation reduction potential of methylene blue and quinone
- 5 Oxidation reduction potential of carcinomatous serum

Table XII shows the results of this investigation in relative degrees of effect in respect to the action of the radiation at 100 K V filtered through 0.6 mm Cu

Conclusion—These tests plead for the theory that in radiation with roentgen rays with a wave length shorter than 0.1 \AA , or with gamma rays, no selective chemical, biological, or seriological reactions in a qualitative sense occur. In a quantitative sense, the conclusion may be drawn for the present that there is a somewhat stronger action of the harder rays for the same quantity of absorbed energy

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MULTIPLE ENDOTHELIOMAS OF THE SKIN WITH METASTASIS

REPORT OF CASE

By W W ROBINSON, M D , *Memphis, Tenn*

THE subject of endothelioma, a term first advanced by Golgi, in 1869, in describing a calcified neoplasm of the dura mater, an endothelial psammoma, forms one of the most notable topics in pathology. No chapter is more incomplete. With our meager conception of the reticulo-endothelial system, and the group of composite tissues which it composes, it is not surprising that this field should offer fertile soil for forensic deliberation among pathologists. Research, directed toward studying the histogenetic origins and capacities for variable differentiation characterizing the least understood of cell groups, would accomplish much toward settling the questions at issue.

Endothelioma of the meninges, pleura, and peritoneum is characteristic, and has been accepted as authentic. Marckwald's (1) case of multiple endotheliomas of the bones is recognized by Ewing. Solitary diffuse endothelioma of the bone, or Ewing's sarcoma, is a definite entity. Multiple and single endotheliomas of the lymph nodes have been described and reported. Recklinghausen in 1897, first recognized primary endothelioma of the lymph nodes as a distinct tumor. Ewing (10) became enthusiastic in the study of these tumors, reported a number of cases, and published a monograph on the subject in 1913. However, his recent studies would show that it is still a medical curiosity. Only a few cases have been recorded in the last two decades. Its incidence varies in different medical centers, which factor is governed by the diversity of opinion as regards the true nature of endothelioma, and the hesitation of some pathologists to make this diagnosis. If the neoplastic nodes are cervical in distribution, and the type of growth is alveolar, primary carcinoma of the nasopharynx, base of the tongue,

that of branchiogenic origin, as well as bronchogenic carcinoma of the superior pulmonary sulcus, must be eliminated before concluding that the lesion is one of primary endothelioma and not metastatic cryptogenic carcinoma. McNamara (22) has recently reported five cases of the multiple type. In this article, McCartney's (14) and Zaffagnini's (15) cases with positive Wassermann are mentioned. This association of syphilis with endothelioma would recall Ewing's (10) contention that the disease is often excited by chronic granulomatous infections. While endotheliomas of the uterus, ovary, and stomach have been described, they have not been accepted as typifying the classical structure of this mesenchymal tumor.

No phase of the subject has suffered as much controversial discussion as that of endothelioma of the skin. Billroth first reported multiple primary malignancies seventy-five years ago, and they have long since ceased to be regarded as pathologic curiosities. Yet, primary endotheliomas of the skin, which are usually multiple, are rare, and do not appear in any of the tables compiled by Warren and Gates (21), in their recent survey and statistical study of the literature bearing on multiple primary malignancies. Substantial proof of their existence is denied by many pathologists, and most of the cases have lost their claim for recognition. They have been classified by critical observers as cylindroma and cellular nevi, derived from constricted anlage of embryonic epithelium situated in the skin. Others, such as the lymphangioma tuberosum multiplex of Kaposi, have been shown to arise from dilated sweat glands. Braun's celebrated case of cylindromatous structure was proven by Krompecher (6) to be of glandular epithelial origin, and designated as epithelioma adenoides cysticum. This

author refers to endothelioma of the skin as "carcinoma endotheliale" Fick (9) is very positive that genuine endothelioma cutis is a non-entity

Many problems bearing on the etiology,

mesenchymal origin, arise from the vascular endothelium or its constituents, and hold a position mid-way between the above two. Functionally, they have the ability to secrete mucin, hyaline, and amyloid

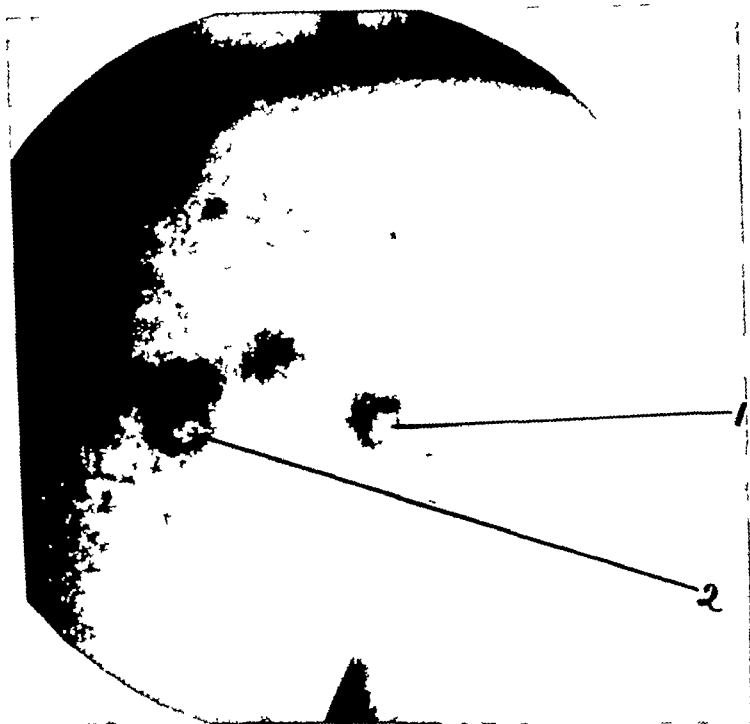


Fig 1 Photograph of posterior aspect of left shoulder showing the various types of skin lesions. The numerals 1 and 2 indicate those nodules which ulcerated and which were incised. These larger, raised growths varied in color from pink to a strawberry hue. Note the three smaller excrescences at the tip of the shoulder lying deep in the dermis. They are representative of the lesions as they first appeared in the skin.

pathology, and clinical symptoms of endothelioma of the skin remain unclear. This confusion may be partly explained by the rarity of the lesion, the unfamiliarity of most physicians with it, as well as a lack of appreciation of the fact that endothelial cells are capable of metamorphosis under changing environment. Under the influence of inflammatory processes, by increasing in number they may lose their typical form, and assume various bizarre shapes, with a corresponding alteration in the arrangement of the cell groups. With their dual nature, they may simulate either epithelial or connective tissue types, that is, they may resemble organoid or histoid growths. Embryologically, they are of

material, thus imitating epithelium. On the other hand, they are capable of producing connective tissue structure in inflammations of the serous cavities, blood, and lymph vessels, as well as granulation tissue, with the formation of epithelioid and giant cells.

In 1906, Zeit (3) published an exhaustive and instructive article on the subject, which has received due praise by Hazen in his book on Skin Cancer. Zeit expresses the opinion that true endothelioma of the skin arises from the endothelium of the perivascular lymph spaces. His conception of the differential diagnosis between this lesion and carcinoma may be quoted as follows:

1 The endothelial cells are intimately connected with the stroma, and cannot be brushed out as in carcinoma After fixa-

is granular and scanty, and the nuclei are relatively large

4 Delicate fibrillar processes extend

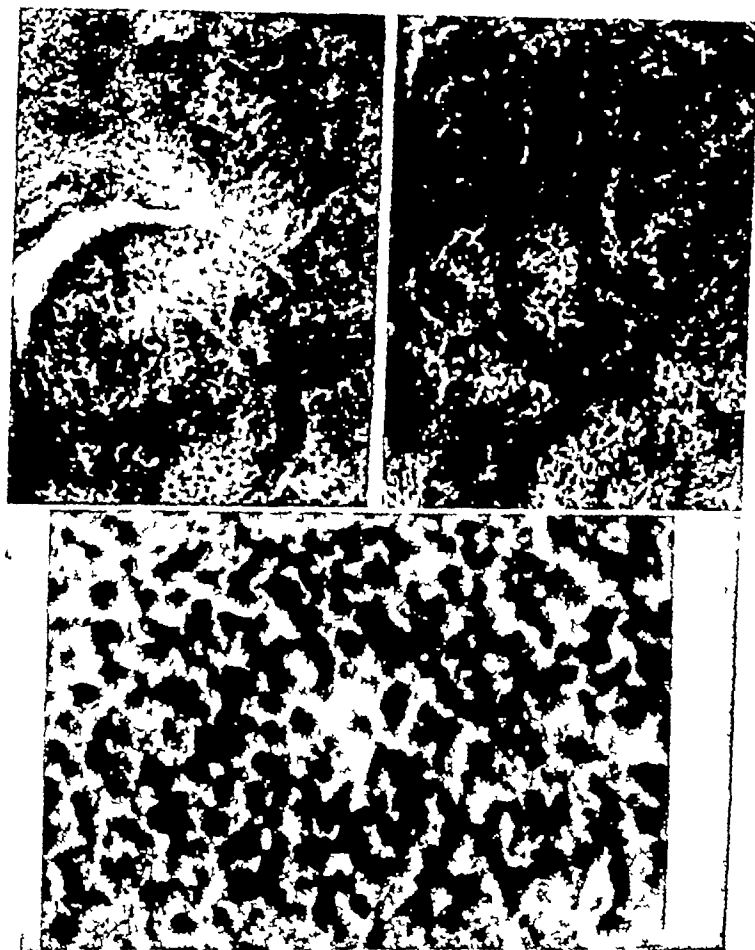


Fig 2 Photomicrographs of original biopsy showing a reddish mulberry like lesion of the skin of right breast. Above low power views showing the alveolar compact arrangement of the cells. Below, high power view portraying the type of cell found. Note the mitotic figures, the glassy cytoplasm of some of the cells, the intercellular processes or fibrils, and the tapering of some of the cells into these processes.

tion with its attendant shrinkage of tissue, the cells cling to the walls of the lymphatics

2 The cells produce intercellular fibrils and cement substance, and form compact layers about the blood spaces

3 Endothelial cell masses form a dense mosaic of many layers of cells, with small, sharply outlined nuclei, surrounded by a broad envelope of clear, glassy, perinuclear cytoplasm. The cytoplasm in epithelioma

from the walls of the alveoli into the proliferating endothelial masses

5 The endothelial cells may be arranged in cords and cylinders, and separate out hyaline material, which picture characterizes cylindroma, or, they may form lumina-like or sieve-like areas, due to the secretory activity of the endothelium which may confuse the condition with myxoma

6 Endothelioma may be distinguished

localized to the scalp, are often of sebaceous gland origin

Ewing (16) describes hemangio-endo-

study to the endothelioblastomas and their classification, states that morphologically the endothelial cell is not highly differen-



Fig 5 Radiographs of right ankle five weeks after initial examination showing similar areas of osteolysis in the os calcaneus

theliomas of the skin, in which there is a preponderance of endothelial cells over new blood vessel formation. He accepts Winkler's (2) endothelial psammoma of the skin, derived from the endothelium of the neurilemma of the nerve fibers, and consisting of concentric masses of endothelial cells, which become calcified. This is analogous to endothelial psammoma of the dura, which was the pioneer endothelial tumor.

Furthermore, Ewing (16) calls attention to certain forms of fascial sarcoma of the extremities, which are derived from the endothelium of the capillaries. While he regards the cellular nevus as always melanomatous, some of the German authors, such as Kaufmann (17), contend that this may be of endothelial origin.

Mallory (11), who has devoted much

tiated, and for this reason it stands out in marked contrast with those cells which are thus characterized when properly fixed and stained. He further asserts (7) that the endothelial cell is of mesoblastic origin, and all tumors derived from this cell, regardless of structure, should be termed endotheliomas.

Without a doubt, the reticulo-endothelial system has manifold capacities for variable cell differentiation and tumor production, of which the last chapter has never been written. In view of the fact that this faculty has been amply demonstrated in different skin lesions of endothelial origin, a number of unquestionable cases of endothelioma cutis with similar pathologic findings have been described and reported, in recognition of the illuminating work of Zeit in differentiating these

study McDonagh (8), in 1912, reported five cases of nevo-xantho-endothelioma of the skin in children. Wise (12), in 1919,

when the blood supply became occluded. This is a practical demonstration of Mallory's dictum (11), in which he directs



Fig 4 Anteroposterior and lateral views of left ankle five weeks after first examination. Note that the lesions have extended to the os calcis involving the tuber calcaneus and neck of the bone.

published an excellent protocol on the subject, and described two cases, one of endothelioma simplex in an adult, and another of nevo-xantho-endothelioma in a child. Jacoby and Grund (19), in 1930, reported the seventh case of nevo-xantho-endothelioma. These authors are of the opinion that the rarity of the disease is in a measure dependent on the recourse to clinical examination alone in the diagnosis of skin lesions, and lack of appreciation that extirpation of lesions for microscopic study is of paramount importance. In the cases described by them, the lesions were confused with multiple disseminated moles, urticaria pigmentosa, and syringo-cystadenomas, until they were biopsied. While Ewing (16) suggests that the origin of these tumors may be from neoplastic growth of endothelial cells of capillary nevi, the fact remains that their microscopic structure conformed to all of the characteristics of endothelioma. The yellowish color of the xantho-endotheliomas reported was due to lipid histiocytosis of the endothelial cells

attention to the phenomena attending defective blood supply in these lesions.

In 1920, Guttierrez (13) described a case in an adult female of numerous subcutaneous nodules of the external portion of the left mammary and pectoral areas, with no mammary involvement. One nodule was present below the right breast. This proved to be a rare case of lymphangio-endothelioma of the skin. In spite of all treatment, which included radiation, nodules continued to form on the anterior abdominal wall, and a fatal outcome resulted.

Ewing found it difficult to eliminate Haslund's (4) case of endothelioma of the skin reported in 1906, which consisted of multiple tumors of the scalp, the history and course of which were typical, in which metastases occurred to the regional lymph nodes, and which proved fatal in 18 months. The type of cell was endothelial with intercellular fibrils. No epithelial characteristics were present. Yet, as Ewing states, such tumors, which are

more deeply situated in the sub-cutis, and felt like buckshot. There were only slight changes in the epidermis overlying these

amination of the abdomen was negative for the presence of fluid, tumefaction, or tympanites, though some tenderness was

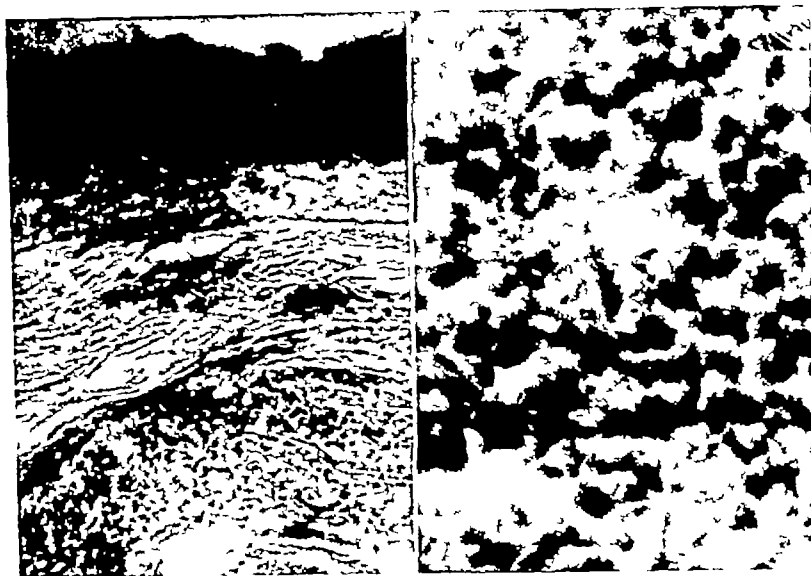


Fig 6 Low and high power photomicrographs of skin nodule on anterior aspect of right thigh above the knee. In the low power view, note that the lesion develops a capsule as it approaches the normal overlying epidermis. In the high power view the effect of irradiation on the cells is apparent. While the type of cell is identical with that in the first biopsy the cytoplasm is swollen and hydropic the nuclei are segmenting and disappearing and there is a tendency to the fusion of cells into syncytial masses.

A large, tender gland was found in the left axilla, but no other enlarged superficial glands were palpated. In the skin of the right breast was another lesion, the size, shape, and color of which reminded one of a red mulberry. Many other nodules were well disseminated over the surface of the body, including the skin of the other shoulder, upper arms, scalp, thighs and legs, and the gluteal regions, 22 in all. Most of these were confined to the corium and sub-cutis.

The left ankle was not noticeably swollen, but some tenderness was elicited over the internal malleolus. The superficial and deep reflexes were normal. The eye, ear, nose, and throat examinations were essentially negative. The thyroid gland was not enlarged, and no circumscribed tumefaction was palpated within its substance. No adventitious sounds of any character were found in the chest. No tumor masses were felt within the parenchyma of either breast. The ex-

amination of the abdomen was negative for the presence of fluid, tumefaction, or tympanites, though some tenderness was noted on deep pressure in the lower right quadrant. The lower margin of the liver descended only one finger's breadth below the costal margin. The spleen was not palpable. A pelvic examination revealed that the left ovary, which was cystic, had not increased in size since the previous observation. The uterus had remained anteflexed, and was of normal size. No tumor masses were found in the pelvis.

Laboratory Examinations—Urinalysis was normal but for a mild albuminuria, leukocytes, 9,365, differential count—neutrophils, mature forms 77 per cent, immature 2 per cent, lymphocytes 19 per cent, and eosinophils 2 per cent, red cells, 3,980,000, hemoglobin (Newcomer), 75 per cent, or 12.68 grams per 100 c.c., color index, 0.9. No malarial plasmodia found. The Wassermann and Mehncke turbidity reactions were four plus positive. A biopsy was made of the skin nodule in the right breast.

Pathologic Report (Fig 2)—*Parenchyma*

tumors, in appreciation of the excellent protocol of Wise, and Mallory's treatment of the subject, it must be conceded that the lesion is a definite clinico-pathologic entity

REPORT OF CASE

Mrs E A J, housewife, white, aged 42 years, entered the Crisler Clinic on Oct 5, 1931, with the complaint of "growths on left shoulder" of three months' duration

Family History—Irrelevant, with no history of malignancy in family

Marital History—The patient had been married 24 years, having had four husbands during this time, two children living and in good health, ages 22 and 17 years, and two miscarriages by last husband, three and nine years before first admission to clinic

Menstrual History—Onset of catamenia at 13 years of age, continuing regularly up to ten years previous to first observation. She had since suffered with irregularity, menorrhagia, and pre-menstrual pain

Operation—Right ovary and both tubes were removed with appendix, in 1927, two years prior to her first examination

Past History—The patient had had all of the usual juvenile diseases, with no injuries. She had entered the clinic two years before the present admission, complaining of colicky pains in the lower abdomen, bilateral, radiating to the small of the back, and aggravated by exercise. Menstruation had been regular since operation, but some menorrhagia as well as scanty flow had been noted. There was nausea and bloating after meals and occasional vomiting. Attacks of syncope had occurred. Pelvic examination had revealed an enlarged cystic left ovary, with uterus anteфлекed. Cholecystograms showed a normally functioning gall bladder. Gastric analysis showed a total acidity of 17', with a free hydrochloric acid of 13'. A mild albuminuria was found. No Wassermann was run at that time. The patient was given an abdominal support,

and advised to return for further observation

The pains in the lower abdomen had persisted during the interval since she was last seen. These were associated with soreness and stiffness in the lumbar region. The gaseous eructation had continued, and since the last spring she had had epistaxis two or three times a week. No skin lesions of any type had been noticed prior to the present efflorescences, and no moles of any character had been removed at any time.

Present Illness—For one year, the patient had observed small buckshot-like nodules on different parts of the skin of the body and extremities, which appeared spontaneously, and which would regress and reform concurrently. These always appeared beneath the skin, and would gradually elevate to produce a tumefaction varying in color from a pinkish brown, or salmon tint, to that of a strawberry. She was mainly concerned with four reddish growths on the posterior aspect of the left shoulder, which were painful, and two of which showed ulceration. These had existed three months. Her home physician thought them to be a form of acne, or possibly a furunculosis. Primarily, only two nodules were present, which developed yellowish, necrotic centers, they were incised, but only a bloody serum was obtained. Almost immediately the adjacent lesions appeared. Six weeks before coming to the clinic, she had slipped and sprained her left ankle. This was strapped, but it remained tender and painful.

Physical Examination—Well developed, fairly well nourished white female, presenting no evidence of cachexia. Four nodules varying in size from that of a pea to that of a lima bean were noted over the posterior aspect of the left shoulder (Fig 1). The color varied from a pink to a strawberry, the larger ulcerated lesion being of the latter color. All were firm in consistency, two were painful to pressure, and the impression was that they were fleshy, and not of infectious etiology. Three smaller nodules, which were located above this group about the tip of the shoulder, were

glands were visualized in the abdomen. The splenic shadow was of normal size and position. A kidney, ureter, and bladder

or trabeculated appearance characterizing benign giant-cell sarcoma, or osteitis fibrosa cystica secondary to hyperparathyroidism



Fig 8 Radiographs of right ankle four months after initial examination. The os calcaneus shows a sharply circumscribed area of osteolysis with a narrow delimiting zone of osteitis.

examination and bilateral pyelograms showed the kidneys to be of normal size, shape, and position, with no deformity of the pelves or calices, both ureters were in normal position.

Due to the tenderness and pain in the left ankle, radiographic study was indicated (Fig 3). There was a definite rounded area of osteolysis 1.5 cm in diameter in the internal malleolus, and a similar one of larger size in the external. The rarefaction was confined to the medulla of the bone in each instance, with indistinct margins. The overlying periosteum was not involved, and showed no reaction whatsoever. There was no expansion of the medullary cavity, and none of the soap-bubble,

Though this is one of the common sites for benign giant-cell sarcoma, the multiplicity of the lesions alone would exclude such a diagnosis. Due to this finding, the bones of the opposite ankle, spine, pelvis, and skull were studied for similar lesions. No definite erosion or rarefaction was found in any of the other bones at this time. There was no linear striation with increased density of any of the vertebral bodies that would suggest the presence of a primary hemangio-endothelioma of the spine, which has been described and reported by Ireland (24) and others. However, this tumor seldom metastasizes to the skin.

Since no other primary tumor was demonstrated, and since the lesions found

Compact masses of rapidly proliferating mesenchymal cells, with distinct cellular membrane, clear or transparent cyto-

Loose areolar connective tissue, supportive in character, and some fibrosis, though there was very little desmoplastic reaction



Fig 7 Radiographs of left ankle four months after first examination. Note the stripping of the periosteum of the internal malleolus also the advanced destruction of the os calcis the involvement of the talus, and the moth-eaten appearance of the cuneiforms, cuboid and the bases of the metatarsals

plasm, and pale vesicular nuclei, with multiple basophilic nucleoli. The arrangement was alveolar about dilated and congested, or collapsed, capillary blood vessels, and about lakes of red cells, where the anaplastic cells were in direct contact with the blood stream. In some areas the growth was intra-luminal. No pigmentation, no epithelial pearls, and no giant cells were present. An average of two to ten mitoses or prophase to the high power field was found. The mitotic figures stood out in extreme contrast in the clear cytoplasm of the cells, most of which were polyhedral in shape. Very distinct intercellular fibrils or processes were seen, and many of the cells seemed to taper into these. Definite hyalinosi of some of the cell masses was noted. The growth was confined to the corium and sub-cutis, and the overlying epidermis, other than showing thinning out of its layers, was normal with intact basement membrane. *Stroma*

Some round-cell infiltration was present. The blood vessels were of the capillary type, dilated, and much engorged, but there was no capillary proliferation.

Pathologic Diagnosis—Malignant endothelioma of the skin.

Roentgen Examinations—On account of the possibility of the skin lesions being metastatic from a deep-lying primary tumor, a complete roentgen study of all viscera was made. The chest was negative for any type of infiltration in either lung-field, and no mediastinal glands were found. The gastro-intestinal series revealed a gastrospasm, with relative fixation of the cecum without deformity, which was interpreted as the result of adhesions from the pelvic operation. No filling defects of any character were found in any part of the alimentary canal. Cholecystograms showed a normally functioning gall bladder. The liver shadow was of normal size, with smooth anterior margin. No

It was quite apparent that we were dealing with bone lesions, which were radioresistant, and which did not respond to specific therapy. There was definite extension of these to the bones of both feet. While these were characteristic of metastatic malignancy, other diseases of the bones, such as multiple myeloma and secondary osteitis fibrosa cystica, had to be considered. The bones of the ankle and foot are rare sites for the lesions of multiple myeloma. Repeated tests of the urine for Bence-Jones protein were negative. The blood calcium was 9 milligrams per 100 cubic centimeters. Orthopedic consultation resulted in the strong contention that the lesions were those of a chronic diffuse syphilitic osteomyelitis, and that the patient had not received sufficient anti-syphilitic treatment.

The patient was placed in the hospital, and intensive specific therapy again instituted. The right femoral lymph node continued to enlarge, and became painful. This was excised, following irradiation. The pathologic report was endothelioma, probably metastatic, invading the sinuses and follicles of the gland. The patient returned home in one month apparently improved. The anti-syphilitic regimen of treatment was continued, and the report from her home physician was encouraging. She had gained in strength, but the left ankle had become more swollen, and the pain almost unbearable. One skin nodule, situated above the right knee on the anterior aspect of the thigh, showed progressive enlargement.

She re-entered the clinic on Feb 9, 1932, three months after the last observation. Her general appearance was cachectic. The skin was of icteroid tint, and there was much loss of weight. The patient was hospitalized and transfused. Following irradiation, the skin nodule above the right knee was excised. This growth was the size of a marble with reddish overlying skin. It was apparently well encapsulated, and cells could be brushed from its meaty, translucent surface only with the greatest difficulty.

Pathologic Report (Fig 6) —Parenchyma Diffuse growth of the identical type of cell found in the original biopsy, cytoplasm clear with small centrally placed vesicular nuclei and multiple nucleoli. No perivascular arrangement was found. Most of the cells were polyhedral in shape, but many were ovoid or spherical, or appeared swollen with granular cytoplasm, and hydropic, faintly staining nuclei, and even fused into syncytial masses, probably as a result of the radiation. The anaplasia was well marked, with two to four mitoses to the high power field. Much infiltration with round cells was present. No pigmentation of any character was demonstrated in any of the cells. The overlying epidermis, while it was thinned out due to pressure, was normal with intact basement membrane. *Stroma* Loose areolar connective tissue, with some fibrosis. Fine reticular fibrils were noted between many of the cell masses. There were many capillary blood vessels, dilated and injected, but there was no hyperplasia of these.

Pathologic Diagnosis —Malignant endothelioma of the skin.

Roentgen examination of the left ankle (Fig 7), which was tremendously swollen, red, and edematous, showed the styloid process of the fibula totally destroyed on its posterior aspect, and the periosteum stripped up. The internal malleolus was rarefied throughout except at its tip, and the periosteum was floating. The calcaneus showed mottling and rarefaction throughout its length, more advanced in the tuberosity and neck of the bone. There was also osteolysis of the talus on its volar surface. A moth-eaten, diffuse rarefaction was seen in the cuneiforms, cuboid, and the bases of the metatarsals. The right heel (Fig 8), which continued to be painful, showed a circular area of osteoclasia about 2.5 cm in diameter in the calcaneus, with a delimiting zone of osteitis. There was also rarefaction in the neck of the calcaneus, and an irregular mottling in the internal cuneiform. Decalcification was noted in the malleoli.

in the external and internal malleoli of the left ankle were distinctly metastatic in character, it was concluded that these

as large as the one excised. In the right femoral trigone, a lymph node the size of a robin's egg was found.

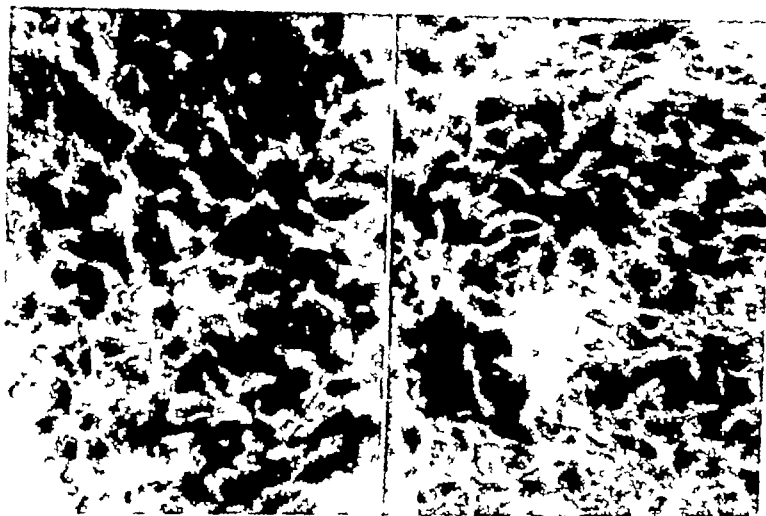


Fig 9. High power photomicrographs of biopsy of internal malleolus of left ankle. While the type of cell is that found in the cutaneous lesions, the form is spherical or pavement like, with fusion into syncytial masses. The cytoplasm is swollen and granular, with dropsical and poorly staining nuclei. Occasional mitoses are seen. These changes are no doubt secondary to irradiation and the edema of associated inflammation.

represented metastases from the endo-theliomas of the skin. Associated with this condition was a positive Wassermann.

Treatment—Nine of the most prominent skin nodules, including those on the left shoulder, were irradiated for diagnostic effect. Each lesion, well shielded with lead, received one S E D. Deep therapy at 200 K V, with 0.5 mm of copper, and 2 mm of aluminum filtration was given to the left ankle through two lateral 10-cm portals in a total depth dose of 600 r units. The patient was put on intensive mixed anti-syphilitic treatment, and advised to return in one month.

She returned to the clinic on Nov 13, 1931, five weeks later. Several of the irradiated skin lesions, especially those on the left shoulder, had entirely disappeared, but there were 19 new ones diffusely distributed over the body surface. The left axillary lymphadenitis, which had received no radiation, had subsided. Adjacent to the site of the biopsy of the skin nodule in the right breast, there was another reddish papular excrescence almost

Radiographs of the left ankle (Fig 4), which was definitely swollen, showed that the areas of rarefaction in the malleoli were more radiolucent and somewhat larger. There was absorption of all bony striæ, and no evidence of bone repair. The periosteum remained intact, and showed no reaction. The os calcaneus also showed a definite area of rarefaction in the tuber calcaneus, about two centimeters in diameter, and another of more advanced destruction in the neck of the bone adjacent to the articular surface for the cuboid.

The patient complained of pain in the right heel at this time. Radiographs of the right ankle and foot (Fig 5) revealed similar areas of osteolysis in the calcaneus, but none in the malleoli. Roentgen examination of the spine, pelvis, and skull did not show any involvement. Small rounded areas of slight rarefaction in the vortex of the skull were interpreted as the shadows produced by the pacchionian bodies. The Wassermann remained four-plus positive.

The right ankle (Fig 11) showed extension of the circular area of erosion in the os calcis, also a similar circular area of rare-

left lower quadrant, radiating to the back. Radiographs of the pelvis showed destruction of the upper half of the left wing of the



Fig 11 Radiographs of right ankle made at time of biopsy of left internal malleolus. There are areas of rarefaction in practically all of the bones. The circular area of erosion in the os calcis shows definite extension.

faction 1.5 cm in diameter in the neck of the talus, and generalized decalcification and rarefaction in the other bones of the tarsus, especially the cuboid. The bases of all the metatarsals were involved. Definite osteolysis was observed in both malleoli.

The patient complained of excruciating pain in the right heel as well as in the left ankle. Deep therapy was applied to both ankles on Aug 24. The irradiation was repeated on Oct 8, and again on Dec 5. Pain persisted, and the destruction of bone continued, although a total depth dose of three SED had been delivered to either ankle and foot. She left the hospital with no relief.

On Jan 19, 1933, the patient again entered the hospital, mainly for the relief of pain. Cachexia was marked. There was a large gland in the left femoral region, and she was suffering from distress in the

sacrum. Deep therapy was given over the pelvis through anterior and posterior portals for the mitigation of symptoms. The following March, since opiates did not give rest, the left leg was amputated at the knee. Yet, she complained there was agonizing pain in the left ankle.

On June 22, 1933, one year and eight months from the time the patient was first seen, or two years and eight months from the time skin nodules first appeared, a lethal exitus occurred. On the day previous, a pulmonary hemorrhage ensued, which lasted until death. Every joint had become swollen. A large tumefaction, which presented above the right knee, the site of excision of a skin nodule, ruptured three weeks before death, and drained an odorless pus. No autopsy was obtained.

COMMENT

This case is reported because it com-

The Wassermann was again reported four plus positive

The patient returned home, and contin-

precise type of cell described in the cutaneous lesions, though many of the cells were spherical or pavement-like with drop



Fig 10 Radiographs of left ankle at time of biopsy of internal malleolus ten and one half months after primary examination. There is a pathologic fracture of the fibula above the external malleolus and advanced osteolysis of all bony structures

ued to grow weaker. Three months later, May 22, 1932, she re-entered the hospital. Two transfusions were given. At this time it was discovered that a tumor the size of an English walnut had developed in the parenchyma of the right breast. This, along with a small nodule in the skin of the left thigh, was removed. The pathologic reports described the same type of neoplastic cell found in the microscopic study of other lesions, or malignant endothelioma. The patient gained a few pounds in weight, but remained very much anemic, with icteroid skin. Liver extract and calcium gluconate were given.

On Aug 20, 1932, a biopsy of the internal malleolus of the left ankle was performed. This was readily done under local anesthesia. The bony structure of the process had been entirely destroyed, and the growth was very accessible. Pathologic examination (Fig 9) disclosed the

sical nuclei, and stained poorly. No giant cells or epithelial structures were present. There was marked infiltration with round cells. A detailed search with special staining methods did not reveal any trace of melanin-like pigment. The growth had invaded the venous channels.

This significant finding furnished conclusive proof that the bone lesions were neoplastic in nature, and metastatic from the tumors primary in the skin. The persistently positive Wassermann indicated an antecedent syphilitic infection of long standing.

Radiographic examination of the ankles at this time showed that in the left ankle (Fig 10) there was a marked osteolysis of the internal malleolus as well as in the external, with a pathologic fracture of the fibula above the malleolus. All of the bones of the foot were more or less involved by the same process, but all joint surfaces remained intact.

shown that melanoma arising from a pigmented nevus has its origin in the melanoblastic cells at the epidermo-dermal junction, and not in deep lying nevus cells. The lesions in question originated in the deeper layers of the dermis and sub-cutis, and became encapsulated as they approached the normal epidermis. No pigmentation of any character was demonstrated in any of the biopsied or surgical specimens. While the quiescent or adult white mulberry melanotic nevi may not show melanin pigment, and while the degree of pigmentation is not an index of malignancy, it can usually be found in varying amounts by diligent search, especially in malignant melanoma. Metastasis occurs simultaneously with malignant change in melanomas, and while the secondary lesions are common in the skin and liver, they are strictly progressive, and show none of the regressive changes manifested in the cutaneous tumors described, nor do they respond to single erythema doses of radiation. Metastasis to the bones is not often found in melanopithelioma. The flat bones are more often affected than the long ones. Sutherland (23), in the analysis of the cases which have come under his observation, has arrived at a similar conclusion. Copeland (20) found only three instances of metastatic growth in bones in 169 cases.

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prises several unusual features. First, endotheliomas of the skin are very rare, and their occurrence has been repeatedly disputed. Virchow has aptly stated that an organ, often the site of metastatic lesions, is seldom the site of primary ones. Second, the multiplicity and wide distribution of the lesions is interesting. These fulfilled all of the requirements of primary malignancy in that each lesion was distinct, presented a definite picture of malignancy, and one being the metastasis from another was improbable, as they appeared simultaneously, and were remotely separated. Third, the bone metastases are remarkable for their time of appearance and initial location. Their rather early occurrence was in all probability due to improper surgical intervention. They were characteristically secondary lesions in that the rarefaction began in the medullary cavity of the bone, and reached the periosteum only by extension. They were all of the osteoclastic type, with no reaction in the bony structure with the exception of narrow zones of osteitis. The primary metastasis occurred at the site of trauma, the injured left ankle, which evidently furnished a point of lowered resistance, the congestion and stasis producing a pabulum favorable to the growth of tumor emboli. However, the bones of the opposite ankle became involved before metastases were found in those of the trunk. Ordinarily, metastatic lesions rarely affect the extremities below the elbows or knees, which are common sites for infectious emboli. Moreover, the growth is usually found at the point of entrance of the nutrient foramina, or of exit of the veins. In this case, the initial metastasis appearing in the malleoli was phenomenal. Fourth, the association of a concomitant chronic syphilitic infection, as the history and a persistently positive Wassermann would indicate, is a coincidence. As it is well known that the reticulo-endothelial system is very susceptible to, and reacts to various, acute and chronic infections, presumably, this may have been the exciting inflammatory agent in producing the endothelial hyperplasia.

The diagnosis was based on the clinical observation of concurrent, voluntary regression and new formation of pinkish to red, papular or nodular skin lesions, originating in the corium and sub-cutis, and diffusely disseminated over the surface of the body, which condition had existed for a period of one year in a relatively well nourished patient. The tumefactions were present where no sebaceous glands are found. The remote possibility of the lesions being metastases from a deep lying primary tumor was excluded by thorough examination, and the fact that the regression of cutaneous nodules is not representative of a metastatic process. The excision or incision of one of the growths was followed by early recurrence, or the appearance of other lesions adjacent to the site of operation. These observations are almost characteristic of endothelioma cutis. While the primary tumors responded to single erythema doses of radiation, their metastases to the bones were definitely radioresistant.

Pathologically, the cut surface of the tumors was translucent, and the cells were brushed from the stroma only with difficulty. After fixation there was no retraction of the cell masses, which occurs in epithelioma. The type of cell in all unirradiated specimens was typically endothelial. These were polyhedral or spindle-shaped, with clear, stainless cytoplasm with small vesicular nuclei, some of which contained many minute nucleoli. While the direct contact of the anaplastic cells with the blood stream is not diagnostic, the arrangement in compact layers, or alveoli, with definite intercellular processes or fibrils is characteristic. In the edematous and irradiated foci, such as the left ankle, the cells reverted to the pavement type, many of which were swollen to spheroidal form, and of considerable dimensions, which agrees with Ewing's (16) observations.

The patient had never had a pigmented mole prior to the appearance of the cutaneous nodules, and no moles had been removed at any time. Becker (25) has

greater ingrowth of fibrous tissue into the gelatinous nucleus, until, at the age of from 8 to 12 years, it is composed almost com-

pearances which were previously not exactly understood Up to the fourth month of fetal life nothing unusual is noted After

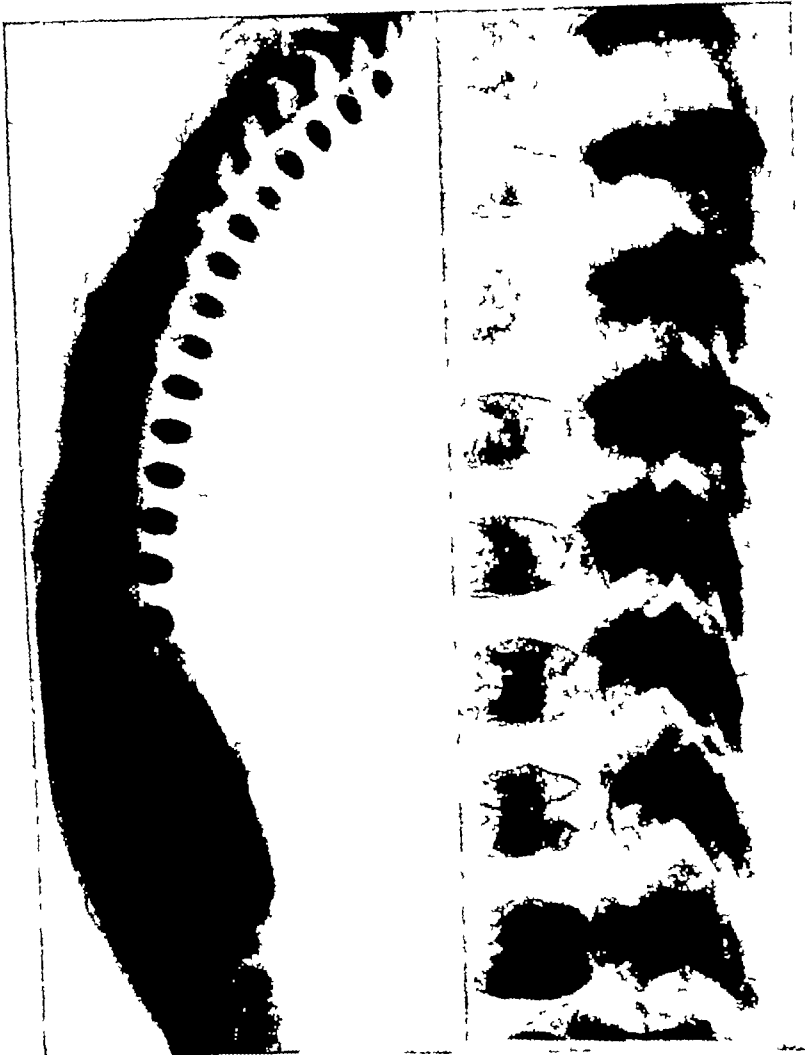


Fig 1

Fig 2

Fig 1 Six months fetus (autopsy specimen) Note dense ossification nucleus

Fig 2 Full term fetus (autopsy specimen) Note excavation anteriorly, due to the central plate not extending as far anteriorly as the upper and lower plates (enlarged)

pletely of fibro cartilage with an abundant gelatinous matrix This progression continues throughout life until we see the senile nucleus, composed of dense fibro-cartilage with little or no gelatinous material However, these changes will be discussed later

Hanson, in an article on "The Development of the Spine as Seen in Skiagrams," satisfactorily explains some peculiar ap-

this period the body is composed of two plates of dense calcified cartilage, between which is a lighter zone which does not extend as far anteriorly In this central zone, cartilage is being absorbed and ossification begins as is evidenced by a dense nucleus in the center After the second year the vertebræ usually have a homogeneous appearance, the spongy bone having extended to

RADIOLOGIC STUDY OF THE DEVELOPMENT OF THE SPINE AND PATHOLOGIC CHANGES OF THE INTERVERTEBRAL DISC¹

By P H MALCOLMSON, M D , *Edmonton, Canada*

ONLY in the past few years has any intensive clinical attention been paid to that highly specialized and very important structure, the intervertebral disc. Although it was originally described by Vesalius, in 1555, and an accurate description of its embryology and anatomy made by Von Luschka, in 1858, it was not until 1927 that Schmorl, of Dresden, made the first clinical and pathologic studies in which he observed the frequent prolapses of the nucleus pulposus into the adjacent vertebral bodies.

Before the publication of Schmorl's painstaking work, the intervertebral disc was generally regarded as a more or less unimportant plate of fibro-cartilage. Now that we have become cognizant with this organ as it really is, we have been able to explain a great number of hitherto inexplicable problems in relation to affections of the spine.

To understand the anatomy and function of the disc it is necessary to know something of its development, which will be discussed in a brief survey of the development of the spine as a whole.

THE DEVELOPMENT OF THE SPINE

There is a certain amount of controversy between different authors on the development of the spine. Remak and Bardeen say that mesenchymal cells arrange themselves in segments about the notochord in accordance with the primitive segmentation of the embryo. These form the provertebrae which are marked off by the intersegmental artery. Now, each is divided into a dark caudal and a light cephalic half. Union of adjacent halves takes place, thus forming the definitive vertebrae.

Williams disagrees with this theory, stating that following the arrangement of mesenchyma there is no formation of provertebrae. According to him, definitive vertebrae are formed merely by differential growth. Very little differentiation takes place in the intervertebral area, which explains its dense appearance.

Keyes and Compere make the most comprehensive explanation, in which they more or less combine the two above-mentioned theories. According to them, the mesenchyma of the sclerotome migrates about the notochord. Segmentation occurs, each segment being composed of a light cephalic half and a dark caudal half and is separated from its neighbor by the intersegmental artery. The cells nearest the artery receive more nutrition and differentiate more rapidly. Finally, these two portions of adjacent segments merge and become the anlage of the vertebral body. The cephalic portion of the caudal mass, being farthest removed from the source of nutrition, remains undifferentiated and is the anlage of the disc. In this connection, it is interesting to note that the disc remains avascular throughout life. As the vertebral portion develops, pressure is exerted on the notochord cells, extruding them into the disc, where they undergo mucoid degeneration and form the nucleus pulposus. At ten weeks the vertebral bodies are composed of cartilage cells, and ossification centers are present. The site of the notochord may be seen as a mucoid streak in the bodies. The disc is composed of the enlarging nucleus pulposus, surrounded by fibro-cartilage which is the annulus fibrosus. After birth, the notochord cells have disappeared and growth of the nucleus pulposus is chiefly by proliferation of the fibrous element. Occasionally, however, remnants of notochord cells are found in the adult disc. As the child becomes older there is greater and

¹ Read by B R Mooney M D , before the Radiological Society of North America, at the Twentieth Annual Meeting in Memphis Tenn Dec 3-7 1934

the epiphyses Kohler agreed with this theory

Hanson, investigating this occurrence

commonly seen in children is a staircase-like formation on the anterior edges of the vertebral bodies Keyes and Compere be-



Fig 7 Calcification of nucleus pulposus Note compression fracture caused by minor injury



Fig 8 Umbilication of the discs Note rupture into the body of a lumbar vertebrae (arrow)

anatomically and radiographically, stated that Hahn's conclusions were inadequate and partly erroneous His dissections on these vertebrae revealed a U-shaped venous channel, lined with a single layer of epithelium The limbs of this "U" faced posteriorly, and could be probed as far back as the vertebral canal Microscopically, these channels were filled with blood and bone marrow Again, refuting him, Hanson states that in a large series of cases the greatest number of slit vertebrae were present in spines of children from 3 to 7 years old Development of the epiphyses, he points out, occurs in individuals aged from 11 to 15 years Supporting Hanson, who has seen these at various ages up to 35 years, we have seen these slits in the vertebrae of a man 37 years of age The disappearance of these, radiographically, is in all probability due to the greater density of the cortical bone as the individual becomes older

Another radiologic appearance not un-

heve this is due to a disturbance in the epiphyseal ring which is derived from the cartilage plates They cite a case which, when x-rayed eight years later, revealed a typical juvenile kyphosis, with herniation of the nucleus pulposus into the vertebral bodies Our case shows no evidence of kyphosis

PATHOLOGY OF THE INTERVERTEBRAL DISC

The simplest way to understand the intervertebral disc is to regard it as a rudimentary joint The cartilagenous endplates are comparable to the articular cartilages—the annulus fibrosus to the fibrous capsule and the nucleus pulposus to the joint cavity

The adult disc is composed of the following structures, in order, from the surface of the vertebra to the center

(1) Thin cortical bone of the body of the vertebra—compact over the nucleus pulposus, and porous at the periphery

(2) Cartilagenous plate—formed of a thin layer of hyaline cartilage which ends

both the upper and lower plates. The excavation anteriorly, caused by the overlapping of the outside plates, has disap-

pearance in the bodies of the vertebrae have been seen by innumerable observers. These were first described by



Fig 3 Man 37 years of age Note persistence of slits in the bodies



Fig 4 Boy 14 years of age Staircase-like appearance of the bodies



Fig 5

Fig 5 Block vertebrae. Note congenital absence of discs. Fusion of second and third cervical vertebrae and of fifth, sixth and seventh cervical vertebrae.



Fig 6

Fig 6 Block vertebrae (lumbar)

peared after two years, except in the lower five to seven dorsal and one to two lumbar bodies. Occasionally, however, it persists as a rounded indentation or a hole just behind the anterior surface of the body.

Hahn, in 1922, who said that they were due to nutritional foramina. He added that they were seen only in the short period of adolescence, associated with a greatly increased blood supply and development of

a tear of the annulus fibrosus, there may be a rupture of the nucleus pulposus, *e g*, posteriorly into the vertebral canal. Such a calamity would probably cause paraplegia. We have seen one such case.

(b) *Lateral shift* This is seen in cases of scoliosis, and although it may not be the underlying cause it may explain the great difficulty in its correction. In such a condition the nucleus is situated at the convexity of the curve.

(c) *Calcification* This was first seen, in 1858, by Luschka in an anatomic preparation, but Calvé and Gallard, in 1922, were the first to describe it in a radiograph of a living subject. The etiology is indefinite but infection (Köhler), disturbed calcium metabolism, trauma, senility, etc., have been suggested as causes.

(d) *Infiltration by other tissues—fibrous tissue, bone, and blood vessels* Fibrous tissue is, of course, the most common and is characterized radiographically by a narrow intervertebral space varying in degree. Such changes accompany old age, or follow trauma as a healing process. Complete ossification of a disc may occur. Ossification of a congenitally small disc may give the picture of congenital block vertebrae.

(e) *Dehydration* Puschel has estimated the water content of the nucleus pulposus for different age groups as follows: full term, 88 per cent, 18 years, 80 per cent, 77 years, 69 per cent. Thus dehydration accompanies senility. However, if there has been any leakage of nuclear material due to any one of several causes, this dehydration is greatly increased.

3 Pathological conditions of the cartilaginous end-plates

(a) The prolapse of the nucleus pulposus, because of its expansile power, is due to congenital defects or weakness of the cartilaginous plates. The latter condition, that is, weakness of the cartilaginous plates, is evidenced radiologically by the presence of smooth excavations in the vertebral bodies, and is described by Smith as umbilication of the disc. This condition is also seen in all softening diseases of the bodies of the vertebrae, viz. osteoporosis, tuberculosis,

etc., and will be described under diseases of the vertebral body. The former, that is, congenital defects in the cartilaginous end-plates, is due to congenital fissures or cracks in the plate, allowing leakage of the nuclear material into the spongiosa of the bodies. When this occurs, a reaction in the bone is set up, resulting in the formation of a cartilaginous nodule eventually surrounded by a wall of sclerosed bone. Radiologically, this is recognized by a narrowing of the intervertebral space, and, after sufficient time has elapsed, by the presence of Schmorl's knots in the vertebral bodies. Both these conditions of the cartilaginous end-plates are probably etiologic factors in epiphysitis, dorsalis juveniles (juvenile kyphosis), and osteo-arthritis, as was explained above.

(b) *Chronic trauma* Schmorl found different degrees of prolapse of the nucleus pulposus in 38 per cent of routine spinal autopsies. He attaches little significance to these findings, but investigated the histories of only a few of the cases. He states, however, that continual, every-day trauma will cause minute cracks in the cartilage plates, consequent dehydration, destruction of the disc, and more wear and tear on the vertebral margins, resulting in osteo-arthritis.

(c) *Acute trauma* Destruction of the disc is frequently associated with compression fracture of the vertebra. The cartilage plates, however, are surprisingly strong and may suffer little or no damage. In connection with this, Schmorl has seen numerous cases showing no injury to the discs at the time of accident, but years later Schmorl's knots were present in distal vertebrae. This demonstrated that injury to these discs had occurred.

(d) *Fibrillation* Schmorl has frequently come across this condition, and likens it to the same condition affecting the cartilages of the knee and hip joint.

(e) Diseases of the disc, such as acute osteomyelitis and tuberculosis, are secondary to diseases of the vertebral bodies. Schmorl has not been able to demonstrate any primary infection in the intervertebral disc.

abruptly anteriorly and laterally by abutting the bony epiphyseal ring, which is derived from it

sectioning a fresh intervertebral disc. As the annulus fibrosus is cut, the nucleus pulposus promptly bulges into the incision



Fig 9 Juvenile kyphosis in a youth aged 21 years. Note narrowing of the discs and multiple ruptures of the nucleus pulposus. Beginning osteoarthritis of upper bodies.

Fig 10 Senile osteoporosis and kyphosis. Herniation of upper and lower discs through a body (arrow), possibly due to persistent notochord.

(3) The annulus fibrosus—a dense fibrocartilagenous envelope, which forms a strong and elastic container for the nucleus pulposus.

(4) The nucleus pulposus itself—a fibro-gelatinous incompressible mass.

It must be noted that the adult disc contains neither blood vessels nor nerves, its nutrition being supplied by lymph. The bony surface of the spongy bone shows minute perforations which allow nourishment to the disc by diffusion. Jung, after very careful investigation, was able to demonstrate nerves in the anterior and lateral ligaments only.

The function of the disc is to transmit static and muscular forces from one vertebral body to another, and on it depends the axis of motion of the spine. The most important portion of the disc—the nucleus pulposus—is subject to the usual laws of fluids, it is incompressible, and its function depends on the integrity of its confining structures, the annulus fibrosus and cartilage end-plates. That it is under tension from these structures is readily demonstrated by

The pressure of the nucleus pulposus after cutting away the annulus fibrosus is 18 mm of mercury. The pressure required to reduce this expansion is 32.2 pounds.

Radiologically, in most cases, conclusions in regard to the condition of the disc must be drawn from the width of the intervertebral space and the condition of the borders of the adjacent vertebral bodies.

There is such a close relationship between all the components of the disc that I think the pathologic changes will be more clearly understood if such changes are discussed separately under each structure.

1 *Congenital absence of the disc.* This is not to be confused with calcification or destruction, which are described below.

2 *Pathologic conditions of the nucleus pulposus and annulus fibrosus.* Any condition that allows leakage of the nuclear material gradually results in partial or complete destruction of the disc. As a result of this leakage and destruction, the vertebral bodies rub together, causing sclerosis, osteoarthritis, and lipping.

(a) *Retropulsion or antipulsion.* Due to

CASE REPORTS AND NEW DEVICES

A SIMPLE METHOD OF LOCATING LOST RADIUM IN AN EMERGENCY¹

By A C OMBERG, M A *Nashville, Tennessee*
Physicist, Department of Radiology
Vanderbilt University Hospital

Despite the great care exercised in the handling and storing of radium it is frequently misplaced, and, due to its small size, may be difficult to locate. If by chance it is thrown into the trash, it usually finds its way to the ash pile by way of the incinerator. Terrestrial temperatures do not affect the radio-activity of the

usually supplied with condenser type r-meters produce a full-scale deflection of 25 r, it would take about two minutes to get a good deflection at this distance. By applying the inverse square law it is found that at a distance of one meter the intensity is only one ten-thousandth of that at one centimeter. This means that the time required to get the same reading would be ten thousand times as long, or about 300 hours. Were the insulation of the instrument perfect it would be possible to locate the radium with the r-meter directly, however, this would be a very tiresome procedure.

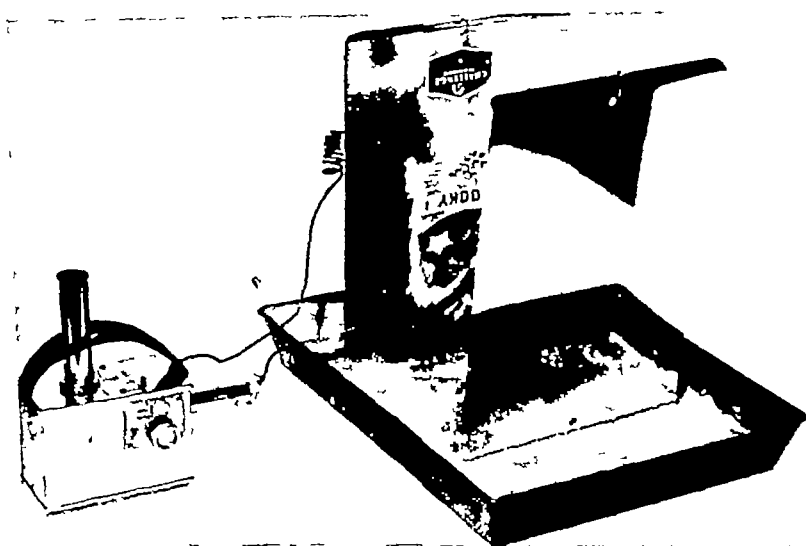


Fig 1 A simply constructed chamber by the use of which 50 mg of radium may be detected at a distance of 25 feet

element but often destroy the containers completely, thereby allowing the radium to diffuse into the surrounding ashes. In this state the only practical method of detecting its presence is by means of the ionization which it produces in the surrounding air. Since the element may be recovered, except for an insignificant loss, it is of first importance that the ashes containing it should be separated and saved.

The purpose of this article is to describe a simple method of locating misplaced radium, in the case of such an emergency, by the use of a condenser type r-meter and an easily constructed ionization chamber.

The problem which is presented is that of measuring the dose, or the amount of ionization of the air. The magnitude of the gamma radiation from 50 mg of element filtered by 2 mm of brass is of the order of 5 r per minute at a distance of 1 centimeter. As the chambers

The simplest way to increase the sensitivity of these instruments is to enlarge the effective volume of the ionization chamber. Since the r is defined as the quantity of radiation which frees a certain charge per cubic centimeter of air, it is necessary only to increase the volume utilized in the same proportion as the desired increase in sensitivity. To change the time required from 300 hours to 2 minutes, a ratio of ten thousand to one, the volume must be changed from the popular one cubic centimeter chamber to a 10,000 cubic centimeter chamber, or should be made a cube with approximately 15 centimeters on a side.

The accompanying photograph (Fig 1) shows a simply constructed chamber which can be set up in a very short time in case of an emergency, and which proves very satisfactory. When it is connected to a Victoreen condenser type r-meter it will detect the presence of 50 mg of radium at a distance of 20 to 25 feet.

¹ Accepted for publication March 25 1935

4 *Pathologic conditions of the vertebral bodies* Any disease that causes softening of the vertebral body results in prolapses of the intervertebral disc into the body. The vertebrae become bi-concave like those of a fish. Finally, the cartilage plate ruptures because of pressure of the nucleus pulposus, and the disc is eventually destroyed. Examples of such diseases are osteomalacia, generalized osteitis fibrosa and Paget's, senile osteoporosis, tuberculosis and neoplasms, benign and malignant.

In conclusion, we would like to add that Keyes and Compere have made some very interesting experimental studies. By various means, such as puncturing the annulus fibrosus to allow nuclear material to escape, they have produced prolapse of the nucleus

pulposus into the adjacent bodies, destruction of the disc, lipping of the bodies, and osteo-arthritis.

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CASE REPORTS AND NEW DEVICES

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By A C OMBERG, M A , Nashville, Tennessee
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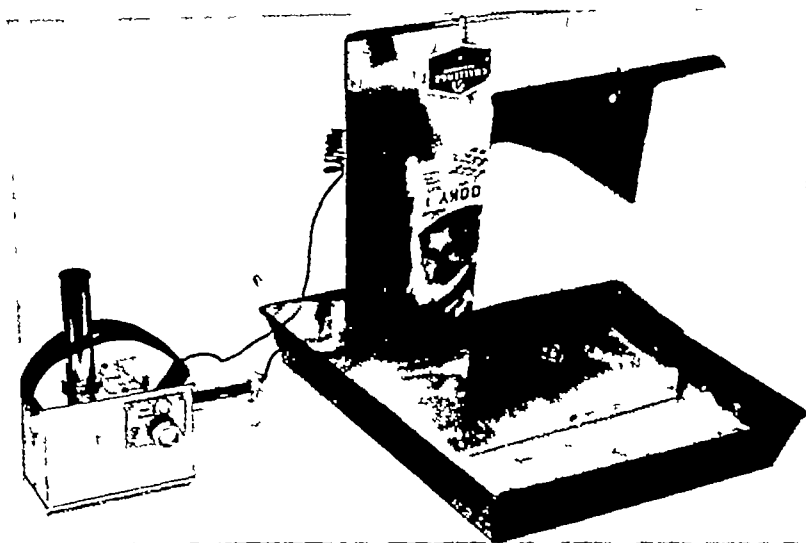


Fig 1 A simply constructed chamber by the use of which 50 mg of radium may be detected at a distance of 25 feet

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It is constructed of two aluminum cookie sheets and a bread pan, and is insulated with sulphur. The cookie sheets (20 by 30 cm) are suspended over the pan in the position shown and so as not to touch the bottom. Melted sulphur is then poured in through a gauze strainer, making an excellent insulator and mechanical support. One plate is connected to the frame of the r-meter by means of one of the screws which hold the handle. The other plate, or cookie sheet, is connected to the terminal in the middle of the receptacle which normally holds the thimble chamber and condenser. The wire leading to this terminal is insulated by a sulphur bushing which is made by placing a wire in a test tube and pouring in melted sulphur. When the sulphur has hardened the end of the tube is broken off and one end of the wire is coiled into a small spring which can be made to fit around the center terminal in the r-meter chamber receptacle. After the sulphur bushing is placed in the r-meter and the connection is made, the outside

of the projecting portion is taped to the meter. (One should be careful to avoid producing a short circuit through the adhesive tape.)

The meter is then ready for use and may be charged to the zero position by turning the charging wheel in the same manner as it is ordinarily used. It will be noticed that the string drifts slowly across the field due to insulation leakage and the small amount of ionization in the air. This leakage rate can be determined with a stop watch. Any increase over the normal rate denotes the presence of radium or some other source of ionization. With the chamber shown, 50 mg was easily detected at a distance of 25 feet.

If radium is located in the ashes they should be tested by the wheelbarrow-full until the "hot" load is found. This should then be tested by the shovel-full until the radio-active portion is found. If the container has not been destroyed, it should be found intact, but if it has melted, it is usually possible to find one or two clinkers which contain the majority of the element.

RIGHT-SIDED AORTA

REPORT OF TWO CASES

By MAX FRIEDMAN B.S. M.D., *New York City*
Assistant Radiologist, *Morrisania City Hospital*

That the condition of right-sided aorta is rare is illustrated by the fact that Biedermann¹



Fig. 1 Shows the knob of the aorta on the right side of the vertebral column instead of on the left. The heart is in the normal position.

reports 12 cases in a series of 20,000 autopsies, and Holzapfel could find only 21 cases of right-sided aorta in a search of the literature between the years 1766 and 1891. Since then several cases have been reported.

The condition should not be confused with transposition of the aorta, in which the aorta arises from the right ventricle and the pulmonary artery from the left. The origin of the aorta is normal but the course is not. It may be accompanied by perforation of the septa, patent ductus Botalli, transposition of the aorta and pulmonary artery, or abnormalities in the branches of the great vessels. Cases are reported in which there is a defect in the ventricular septum immediately below the origin of the aorta so that the vessel arises from both ventricles. The aorta is then broadened and the pulmonary artery narrowed. In these cases the diagnosis was made at autopsy.²

The condition may occur alone in perfectly healthy persons and need not cause symptoms, or it may be an accidental finding, as it was in both our cases. The most prominent symptom of these was difficulty in swallowing, due to an abnormal position or narrowing of the esophagus which is sometimes pressed upon by the aorta or the left subclavian artery. Renander³ reported a case which was fluoroscoped because of difficulty in swallowing. The findings were a right-sided aorta and a rather marked dis-

² AESSMANN, H. *Die Klinische Röntgendiagnostik der Inneren Erkrankungen*. Vogel, Leipzig, 1929.

³ RENANDER. Roentgen Diagnosed Anomaly of Esophagus and Arcus Aortae. *Dysphagia Lusoria*. *Acta Radiol.* 1926, 7, 298.

¹ BIEDERMANN, F. Roentgenography of Aortic Arch on Right Side. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, February, 1931, 43, 168-187.

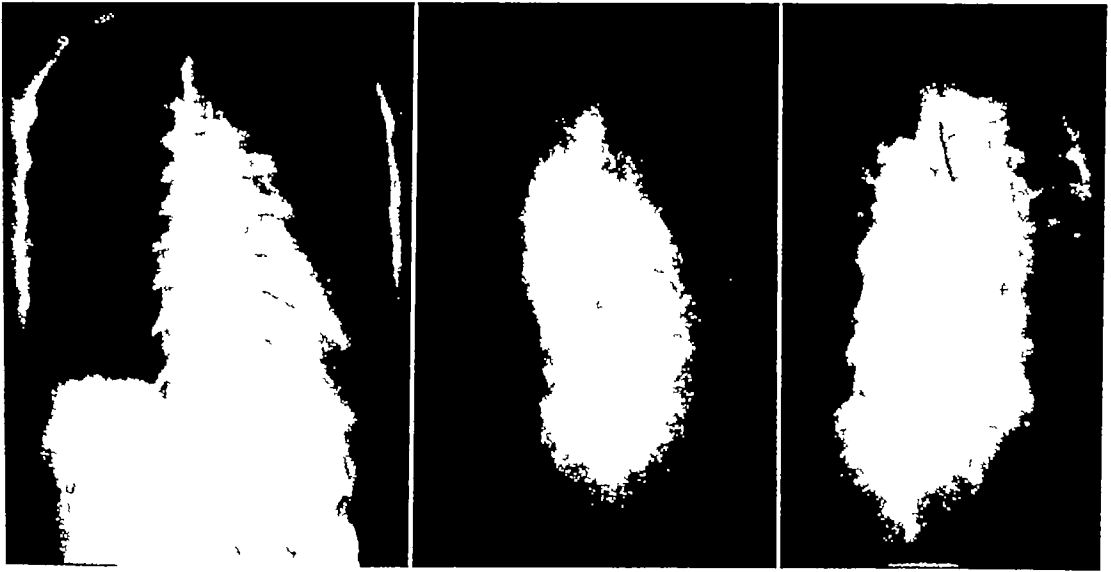


Fig 2 Bucky film showing the knob of the aorta on the right side. The descending aorta and thoracic aorta run to the right of the dorsal vertebræ as far as the twelfth where they turn toward the left

Fig 3 Right oblique position showing absence of the knob of the aorta and of the aortic depression in the esophagus

Fig 4 Left oblique position showing the knob of the aorta and the aortic depression in the esophagus

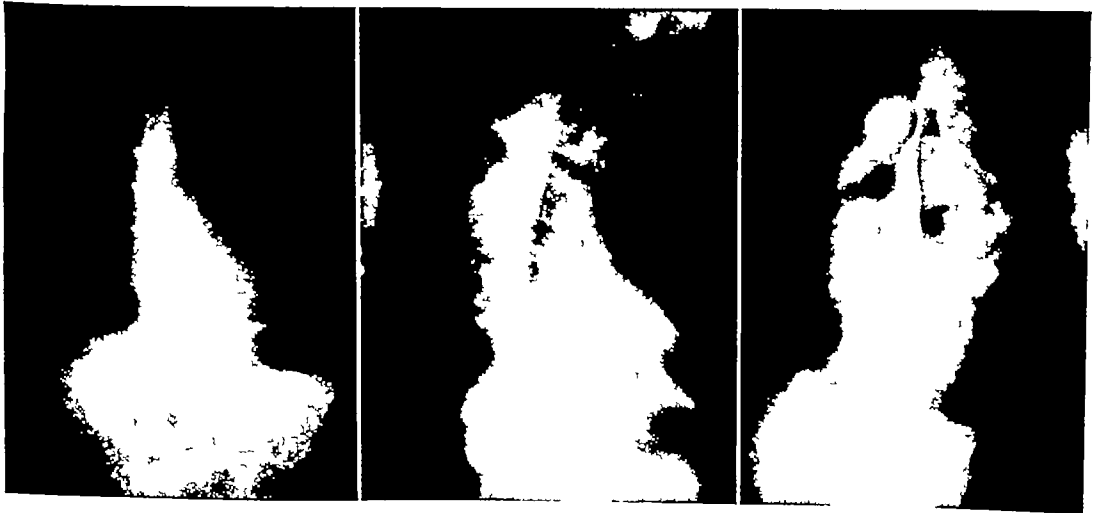


Fig 5 Showing the knob of the aorta on the right side of the vertebral column instead of on the left

Fig 6 Right oblique position showing absence of the knob of the aorta and of the aortic depression in the esophagus

Fig 7 Left oblique position showing the knob of the aorta and the aortic depression in the esophagus

placement of the esophagus to the left and forward

Roentgen Findings—The knob of the aorta is not present in its usual left position. To the right side of the vertebræ, at the same level, an oval shadow which represents the knob of the right-sided aorta is seen, which pulsates on fluoroscopic examination. In the right oblique position the knob is not seen but it appears in the left oblique position. The aortic depression

in the esophagus is also seen in the left oblique and not in the right oblique position, which is the normal. This depression may be normal in depth or it may be exaggerated to any degree by a further abnormal position of the aorta or left subclavian artery. The esophagus may be displaced to a marked degree, as shown in Renander's case.

The following cases are presented because of the extreme rarity and great interest of the con-

dition One case was of the pure type while the other was accompanied by another abnormality

Case 1 E M, colored female, aged 30, entered the Morrisania City Hospital Dec 7, 1932, complaining of attacks of fainting associated with palpitation and dyspnea on slight exertion These conditions had been present for the past ten years but of late they had become more frequent, occurring daily When a child she was told she had heart trouble As far back as she can remember she has become dyspneic upon slight exertion Physical examination showed a systolic thrill over the precordium Rough high-pitched systolic and diastolic murmurs were present over the entire precordium These signs were interpreted as being due to congenital heart disease of the nature of a septum defect The electrocardiogram showed evidence of some myocardial disturbance in both auricles and ventricles, such as is found in congenital heart disease and in conditions in which right heart pathology is present.

Radiographic and fluoroscopic examination of the heart (Fig 1) showed an absence of the knob of the aorta in its usual left position Immediately below the inner end of the right clavicle an oval pulsating shadow was seen, adjacent to and continuous with the superior mediastinal shadow This was interpreted as the knob of a right-sided aorta A film (Fig 2) made with the Bucky diaphragm in order to demonstrate the descending aorta showed that this vessel ran at the right of the dorsal vertebrae as far as the upper border of the twelfth, where it turned toward the left Fluoroscopic examination and a film made in the right oblique position (Fig 3) did not show the knob of the aorta nor did they show the depression which the aorta usually makes in the esophagus in this position In the left oblique position, however (Fig 4), these did appear very plainly Conclusion right-sided aorta

Case 2 (Borrowed from Harlem Hospital with the kind permission of Dr William Snow, radiologist) R B, colored male, aged 38, admitted to Harlem Hospital Oct 31, 1932, died Dec 16, 1932 Diagnosis essential hypertension, chronic uremia History None referable to the anomaly Physical examination showed the heart to be enlarged to the left Sounds were of good quality At the aortic orifice there were soft blowing systolic and harsh diastolic murmurs over the mitral area, a soft systolic murmur and a snapping second sound (P_2 greater than A_2)

Radiographic examination of the heart (Fig 5) showed a concentric hypertrophy of the left ventricle The aortic knob was seen on the right side instead of on the left and the descending

aorta was seen to run to the right of the dorsal vertebrae as far as the tenth, where it turned to the left In the right oblique position (Fig 6) the aortic knob and the aortic depression in the esophagus were absent but they were plainly visible in the left oblique position (Fig 7) Conclusion right-sided aorta

SUMMARY

- 1 Right-sided aorta is very rare It is due to abnormal development
- 2 It may occur in pure form or associated with other congenital anomalies
- 3 It may not produce symptoms and may be an accidental finding
- 4 The roentgen findings are a mirror image of the normal
- 5 Two cases are presented, one pure and one with associated interventricular septum defect

1940 Grand Concourse

THE ROENTGENOLOGIC DIAGNOSIS OF GENERALIZED FETAL EDEMA

By IRA H LOCKWOOD M D, and FRED Y KUHLMAN M D, *Kansas City, Mo*

Generalized fetal edema has been described by Ballantyne (1) as "a morbid condition of the fetus, characterized by general anasarca, the presence of effusions in the peritoneal, pleural, and pericardial sacs, and usually an edema of the placenta, resulting in death of the fetus or infant, before, during, or very soon after birth" The condition has long been recognized, having been described by Guillemeau in 1621 Its incidence has been variously estimated at from 1 in 1,200 to 1 in 3,000 births

The etiology of generalized fetal edema is obscure Two general groups of causative factors are noted (1) abnormality of the fetus itself, and (2) toxic or metabolic derangement of the mother Broekhuizen (2) classifies the causes as follows

(A) Fetal causes

- 1 Heart and vessels
 - (a) Fetal endocarditis
 - (b) Congenital absence of a chamber of the heart
 - (c) Small foramen ovale
 - (d) Obliteration of Botallo's duct
 - (e) Displacement of heart and vessels due to diaphragmatic hernia
 - (f) Situs inversus
- 2 Kidneys and genito-urinary system
 - (a) Congenital
 - (1) Aberrant artery pressing on umbilical veins
 - (2) Cystic degeneration



Fig 1 Lateral roentgenogram of abdomen showing wide zone of subcutaneous edema of fetus, particularly of the thighs

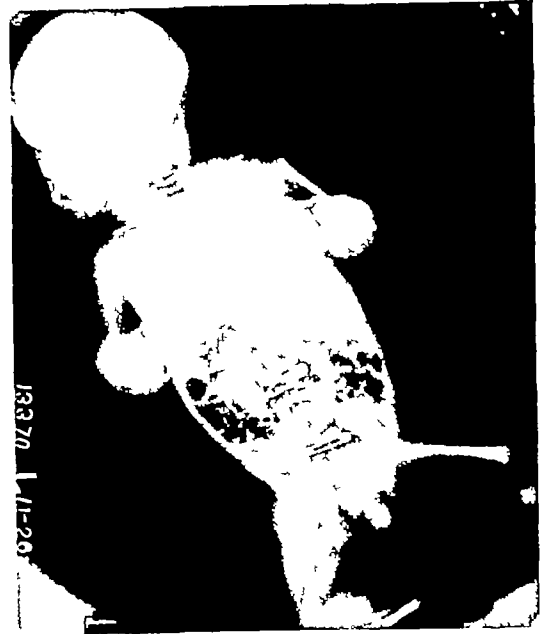


Fig 2 Postmortem roentgenogram showing edematous condition

- (b) Hyperplasia of kidneys
- (c) Hypertrophy of kidneys
- (d) Fetal nephritis
- 3 Liver
 - (a) Hypertrophy
 - (b) Atrophy and cirrhosis
 - (c) Hypertrophy of liver and spleen
- 4 Blood
 - (a) Fetal leukemia
- 5 Fetal syphilis
- 6 Fetal peritonitis
- 7 Absence of thoracic duct
- (B) Due to conditions outside the fetus
 - 1 Thrombosis of umbilical vein
 - 2 Edema and hypertrophy of placenta
 - 3 Hydrops of the entire ovum
- (C) Due to remote maternal conditions
 - 1 Malaria
 - 2 Endometritis
 - 3 Hydremia
 - 4 Leukemia
 - 5, Chronic nephritis and kidney of pregnancy

This author does not mention erythroblastosis of the newborn, which seems to be one of the more common causes of universal edema (3)

The importance of prenatal diagnosis of this condition cannot be underestimated, for these infants may be so edematous that a

normal delivery is impossible (4) Diagnosis by palpation is usually unsuccessful since hydramnios is frequently present Insofar as we have been able to ascertain, the roentgenologic diagnosis has not been reported Gill and Auld (5) mention such a possibility, stating in their report, "a roentgenogram showed a baby of apparent full-term size with flaring ribs and distended arms which, upon delivery, was explained by the edematous condition of the fetal body "

CASE REPORT

Mrs I P, aged 26 years, was admitted to St Luke's Hospital on the service of Dr Ralph R Wilson, with a diagnosis of pregnancy (34 weeks), hydramnios, and diabetes mellitus

Past History—Third pregnancy First, five years ago, at which time a very large child died suddenly of an undetermined cause during delivery Second, three years ago, at which time the diabetes was discovered Normal baby delivered at term Since that time the mother has been taking from 30 to 40 units of insulin daily

Present Illness—Considerable nausea, with little vomiting early in pregnancy Last four weeks abdomen has been enlarging rapidly Three weeks before delivery feet and legs were quite edematous

Physical Examination—Enlarged abdomen, McDonald measurement of 43 centimeters Fetal heart tones were indistinct Position of

fetus was not well defined. Legs and feet were edematous. B P 140/86.

Laboratory Findings—Urine, positive for sugar with one drop, trace of acetone. Blood Wassermann and Kline negative. Blood counts normal. Blood chemistry: N P N 30, creatinine, 1.6, chlorides, 500, sugar, 282.

Course—The patient was observed for several days, during which time the diabetes was brought under control. It was decided to induce labor, and an x-ray consultation was requested to exclude a possible hydrocephalus or other type of monster.

X-ray Findings—"Hydramnios. Normal bony development of fetus. In the lateral projection there is an unusual delineation of the soft tissues of the fetus, with a zone of lessened density in the subcutaneous tissues, varying in width up to one-half inch. This zone contrasts markedly with the denser amniotic fluid and muscle tissue of the fetus. It suggests either an edematous or excessively fat fetus. In view of the fact that the fetus is premature, the latter possibility can be excluded."

Labor was induced and a living child delivered by low forceps. A large amount of amniotic fluid was present which showed a sugar content of 74 mg per 100 cubic centimeters. There was a large amount of vernix caseosa. The fetus was edematous and purplish in color. Urine obtained five minutes after birth showed a reduction of Benedict's solution with 20 drops, with a trace of acetone and diacetic acid. The child's respiration became labored, the temperature rose to 108.8 F, and death ensued six hours after delivery. A postmortem x-ray negative shows the wide zone of subcutaneous edema.

Summary of Autopsy Findings—Weight, 9 $\frac{1}{2}$ pounds. Premature. Generalized edema of all tissues, eyes swollen shut, marked swelling of cheeks and scrotum. Skin purplish in color. Free fluid in pleural, peritoneal, and pericardial cavities. Liver. Omental fat and retroperitoneal tissues edematous. Spleen and testicles congested. Lungs. Innumerable small subpleural hemorrhages, massive consolidation, with small areas of crepitation, microscopically the alveoli were filled with a semigranular precipitate, with a pigment which was apparently meconium. Thymus. Hyperemia, with small punctate hemorrhages. Heart. Subepicardial hemorrhage 1.5 cm in diameter, separation of muscle fibers by edema, hemorrhage and congestion of myo-

cardium, foramen ovale and ductus Botalli patent, with functioning valve over former Pancreas. Interstitial hemorrhages, with a few lymphocytic foci. Adrenals. Extensive hemorrhage with degenerative changes. Kidneys. Extensive medullary hyperemia. Head. Marked edema of scalp, with hyperemia, tremendous accumulation of subarachnoid fluid flattening the convolutions of the brain, fluid contained 48 mg sugar per 100 c.c., falx cerebri and tentorium normal except for hyperemia. Direct blood smears showed no increase in nucleated reds, definite increase in polychromasia. The placenta showed a few scattered infarcts.

Pathologic Diagnosis—Hydrops fetus universalis, amniotic aspiration pneumonia, bi-lateral, massive, with punctate hemorrhages of epicardium and pleura, marked subarachnoid edema, slight interstitial pancreatitis.

The postpartum recovery of the mother was uneventful.

Comment—With improved technic for making short x-ray exposures, we have found it possible, in the lateral projection, to obtain a more or less well defined outline of the soft tissues of the fetus in a large percentage of the cases in the last two or three months of gestation, without the use of any contrast medium. This definition is apparently caused by the subcutaneous fat of the fetus, contrasting with the denser amniotic fluid and fetal muscle tissue.

CONCLUSION

A case of generalized fetal edema, with hydramnios, due apparently to maternal diabetes, is presented with roentgenologic and pathologic findings. The value of the lateral roentgenogram made with a short exposure time to visualize soft tissues is stressed.

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EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

THE AMERICAN SOCIETY OF X-RAY TECHNICIANS

The tenth annual meeting of the American Society of X-ray Technicians was held in Dallas, Texas, May 21-24, 1935. Several hundred x-ray technicians from every part of the United States were in attendance, representing some of the best known medical schools and hospitals of the country.

The officers who presided at this meeting were Thomas W. Lough, M.A., R.T., of Seattle, Washington, *President*, Myrtle L. Jones, R.T., of Chicago, *First Vice-president*, Bertha A. Malakowsky, R.T., of Sheridan, Wyoming, *Second Vice-president*, Sister M. Blanche, R.T., of Duluth, Minn., *Third Vice-president*, and Alfred B. Greene, B.Sc., R.T., of Oak Terrace, Minn., *Executive Secretary-Treasurer* and *Editor* of the journal "The X-ray Technician."

The program consisted of numerous interesting and instructive papers, most of which were on technical subjects of use to those making roentgenograms of the human body. Some of the papers presented described new and most useful technical procedures, which should prove of distinct advantage to many roentgenologists who have to do their own technical work.

The Scientific Exhibit, which presented numerous x-ray film demonstrations of the highest order, was well worth seeing, as it showed the marked progress which is being made in the technical field of roentgenology. This, of course, is very important as every roentgenologist is desirous of producing the very best x-ray films for correct interpretation, and any individual or group of individuals that can make this possible is certainly to be encouraged.

A few years ago, when the American Society of Radiographers, now the American Society of X-ray Technicians, was organized, it met with strong opposition by members of the radiological profession, because at that time, it was thought that members of a technicians' organization would in their enthusiasm carry beyond their limitation and invade the domain of medicine. It is certainly most gratifying to

be able to say that time has shown that this organization has kept up the high standards it first set for its membership, and has restricted its activities strictly to the technical field of radiology. Yet, there are some members of the radiological profession who do not yet understand the reason why technicians should be organized, and also what good can come of such an organization. In order to find out first-hand just what the American Society of X-ray Technicians stood for, and what type of membership composed it, and, in fact, to obtain all information possible, your Editor accepted an invitation from this body to be guest speaker at this convention.

I was in attendance from the opening day, until the last day of their meeting. I wish it to be clearly understood that my acceptance of their invitation was not for the purposes just mentioned, as an independent individual, I had long ago formed my own personal opinion of the good they were doing. In accepting their invitation, I felt highly honored, and attended not as a representative of Organized Radiology but as a private in the rear rank. However, as mentioned, it afforded me the opportunity of gathering information which I believed would help to clear away certain misunderstandings in regard to activities which existed in certain quarters.

I was very much impressed by the high degree of intelligence displayed by the members of this organization. Some of them are university graduates, whose academic education would permit them to enter medical school, law school, or a school of engineering, yet, they are content and happy in their chosen field, using their talents in devising better and more practical technical procedures which are proving helpful to radiologists.

One of the interesting observations I made was that at no time did I hear anyone speak of interpretation of x-ray films. I was impressed with their earnestness to comply with their creed, namely, "The Radiographer's Creed." It may be of interest to quote it here:

"We believe that every radiological techni-

cian should work under the direct supervision of, and be directly responsible to, some member of the radiological, medical, surgical, or dental profession, such member being generally recognized in his profession as qualified to do the work attempted¹

"We are opposed to the so called schools (whether conducted by professional men or laymen) that urge the attendance of any or all laymen, with the promise of speedy preparation and handsome remuneration for their services. In other words, we are opposed to the commercial school

"We believe that the standard for all plate and film work should be established by the professional man doing the work of interpretation, and that it is our duty to qualify ourselves to produce the desired standard"

These lofty ideals are being religiously carried out by the members of this organization. Of course, there is no doubt but that at times some may stray away from the righteous path, but they are promptly dealt with by expulsion. It is obviously true that it is far better for a group of x-ray technicians to be organized, especially so when they have such lofty ideals and can be disciplined when the occasion arises, than to have no such organization, each individual doing whatever pleases him, without restraint

The subject of the x-ray technician has assumed the proportion of a tremendously important problem for the radiologists to consider. We feel that if the radiologists will make a sincere effort toward a better understanding of what the American Society of X-ray Technicians are doing, and what they stand for, less misunderstanding will occur and a more harmonious relationship will exist between them and the radiologists. I, for one, would be among the first to help suppress any enthusiastic feeling they may have regarding the violation of any medical practice act, but I have no such fear, as I have been sincerely impressed with their honest attitude, restricting themselves purely to the technical phase of radiology. It should be recalled that they have shown quite definitely in the past their desire of co-operating with us. We can all remember that the name under which they first organized was the American Society of Radiographers, which caused dissension among the

radiological profession, because it was felt that the word "radiographer" could easily be confused with that of "roentgenography," etc. When their attention was called to this, they submitted the question to some of our most prominent radiologists, who agreed that the word "radiographer" could cause confusion, and, because of this, they voluntarily changed the name to that of "x-ray technician"

The American Registry of Radiological Technicians has several prominent members of the radiological profession who were appointed by our national radiological societies to certify to the qualification of x-ray technicians by examination. Because of this recognition, and because of their adherence to a strict code of ethics, we should give them the encouragement they so well deserve, by helping them increase their membership and by encouraging our own technicians to become registered by examination

SHALL WE TELL CANCER PATIENTS THE TRUTH?¹

By WRIGHT CLARKSON, M D, and
ALLEN BARKER, M D, Petersburg,
Virginia

During the past few months several editorials have appeared on this subject. Some authors are opposed to mentioning the word "cancer" to patients, while others feel that they should be told everything. Here, as elsewhere in life, no one rule will apply to every case. If we are dealing with a minor, at least one of the parents should know about the condition. If the patient is mentally deficient, no good will be accomplished by telling him. But in most cases, in which we are dealing with an adult of normal mentality, this question cannot be justly decided by either physician or relative, and, therefore, as often as it is practicable the decision should be made by the patient himself. Those who do not desire to know the truth about their physical condition will often so inform the attending physician, and there is no good reason why the physician should not follow these instructions so long as a lack of knowledge on the part of the patient as to the seriousness of the condition does not interfere with treatment. The physician's sacred duty is to his patient and not to some friend or relative of the patient.

¹ Editor's note. Notice that chiropractors osteopaths and representatives of other systems of practice are not mentioned and I have been assured that they will not enroll as a member any technician who works for such

¹ This article has appeared in the June, 1935 issue of Southern Medicine and Surgery

A physician should not shock a patient by bluntly telling him that he has an incurable cancer. He can always win the confidence of his patient at the first visit by being perfectly honest and saying, "I do not know." This applies equally to the specialist and to the referring physician. The diagnosis in these cases should be made only by those physicians who are specially trained in this field, and should be as accurate as human endeavor can make it. To do this the tissue must be examined under the microscope, and, since proper preliminary irradiation tends to minimize the danger of removing the tissue for examination, the physician has an opportunity during the interval between irradiation and biopsy to convince his patient of the fact that *cancer is curable*. Cancer, in reality, is just as curable as diphtheria, but a patient who receives early treatment for diphtheria and recovers tells his neighbors all about it, while a patient cured of cancer usually prefers not to mention it. Your patient will be interested in learning about this and the fact that a large percentage of the cancers occurring to-day are being permanently cured.

In handling a patient with an apparently hopeless neoplasm, a physician must carefully study the mental as well as the physical aspects of his patient. If, after a careful analysis of a case, the physician is convinced that it is best for the patient not to know the exact status of his condition at that time, he is perfectly justified in withholding the truth temporarily, provided the patient is kept under constant observation and some intelligent and dependable member of the family is informed as to the true condition. For instance, we recently had a patient twenty-seven years of age with a teratoma of the testicle and numerous metastases in his lungs, as shown on roentgenograms. The metastases could not be removed and they proved to be radio-resistant. From the rate of growth, we felt certain that the patient could live only about one year, which proved correct, but at the time he was in good physical condition, and he was able to continue his duties for about nine months, in peace, happiness, and without pain. No good could have been accomplished by explaining the true condition to this young man when he first came to us.

A physician should never tell a patient nor his family that his case is hopeless and that he will soon die. We must remember that physicians do not keep the "book of life" and,

therefore, such an unqualified statement may prove to be incorrect. In 1930, Dr. J. M. Williams, of Petersburg, Virginia, sent us a patient with a carcinoma of the left breast with metastases in the bones of her hand, pelvis, femur, and one toe. This was proven by microscopic sections examined by many eminent pathologists. We did not expect her to live six months but, following roentgen therapy alone, she is clinically well to-day, five years later, and roentgenograms show no evidence of cancer remaining in her body.

Such cases are rare, but every physician treating a large number of cancer patients encounters frequent surprises at the results obtained in his cases.

Be optimistic to the end, and be honest with your patients. If they really are sincere and persistent in their desire to know the truth, we can see no justification in continuing to deceive them. The fear that accompanies the uncertainty as to the possibility of impending death must be worse than death itself, and while suicides are rare among cancer patients, the few that do occur are usually among incurable cases.

"Honesty is the best policy" here as elsewhere in life, and while in some cases it may be wise to withhold the facts temporarily, it is best to tell the patient the truth in due time, and to request him not to tell those who will constantly remind him of his condition, for it is obvious that curious and inquiring neighbors may create a mental complex that will be detrimental to his physical and social welfare.

ANNOUNCEMENTS

NEXT ANNUAL MEETING

PROGRAM PLANS

During the week that the American Board of Radiology conducted examinations in San Francisco, Dr. Lloyd Bryan, *President*, called an informal meeting of the Program Committee, six members being present, including Dr. Edwin C. Ernst, Chairman of the Publication Committee, and Dr. Leon J. Menville, Editor of the Journal.

The program of the Annual Meeting and the publication of the Journal were discussed, and the President stated that satisfactory progress has been made toward plans for the Annual Meeting in Detroit, next December.

The program will be conducted almost entirely along the symposium line, and the following symposium leaders have been signed up and are now arranging their groups

²¹ Radiation Therapy, Francis Carter Wood, M D, New York City

Urology, Bernard H. Nichols, M D, Cleveland, Ohio

Radiation Therapy of Breast Tumors, Albert Soland, M D, Los Angeles, California

Bone Pathology, C G Sutherland, M D, Rochester, Minnesota

Co-relation of Physics and Clinical Data of Super-voltage Therapy, R R Newell, M D, San Francisco, California

Thoracic Pathology, Harlan P. Mills, M D, Phoenix, Arizona

Glands of Internal Secretion, W H McGuffin, M D, Calgary, Canada

Gastro-intestinal Pathology, Leo G. Rigler, M D, Minneapolis, Minnesota

Radiation of Non-malignant Conditions, Edwin C. Ernst, M D, St. Louis, Missouri

Symposium on miscellaneous subjects

The clinics will be in charge of B H Orndoff, M D, of Chicago, and C K Hasley, M D, of Detroit

Several prominent guest speakers have been arranged with, among them Dr. Chevalier Jackson and Dr. Charles Geschickter, and at least one or two prominent European radiologists

The Carman Memorial Lecture will be delivered by Dr. Arthur C. Christie, of Washington, D C

The scientific exhibits will be in charge of Dr. Paul Titterton, of 212 Metropolitan Building, St. Louis, Mo., and exhibitors are requested to apply directly to him

MIDSUMMER RADIOLOGICAL CONFERENCE

Denver has a Radiological Club, which will sponsor a Midsummer Radiological Conference, to be held in Denver, Colorado, Thursday and Friday, August 29 and 30, 1935

The program is as yet tentative, but will probably consist of symposia on Diseases of the Chest, Diseases of the Gastro-intestinal Tract, and Neoplastic Diseases. In addition, it is planned to devote an afternoon to the consideration of the Development, Anomalies, and Diseases of the Spine

Parts of this program will be given by Denver men, but it is anticipated that several radiolo-

gists of recognized standing from other states beside Colorado will present a major part of the program

In the next issue of RADIOLOGY the Editor hopes to be able to publish the program in full. Meanwhile, inquiries may be addressed to Frank B. Stephenson, M D, Metropolitan Building, Denver

LATIN-AMERICAN CONGRESS OF PHYSICAL THERAPY, X-RAY, AND RADIUM

The Latin-American Congress of Physical Therapy, X-ray, and Radium will hold its first annual meeting in Mexico City from August 29 to September 5, it is announced by Dr. Cassius Lopez de Victoria, Executive Director of the organization. The National University of Mexico will act as host to their North American colleagues, and the Government will participate in extending hospitality to the delegates

To facilitate the attendance of American physicians at this Congress, a nineteen-day convention cruise has been arranged, with steamer, rail, hotel, and sightseeing costs included in one all-expense fee. The convention cruise and all of its advantages will be available not only to the physicians, but to members of their families and their friends

Five special tours to the Latin-American Congress and return have been arranged by the American Express Company, that has been asked to direct the Congress Cruise. The first of these, which is expected to prove most popular is a round-trip by steamer, the *S S Yucatan* having been especially chartered for the purpose of the Congress

It will also be possible for physicians to make the round-trip by rail, or to go by steamer and return by rail. Special arrangements have also been made for a return trip by rail, including a stop over at Kansas City, for those who desire to attend the Fourteenth Annual Scientific Session, Congress of Physical Therapy, on September 9, 10, 11, and 12

In addition to first-class hotel accommodations in Mexico City, delegates registered for the cruise will enjoy sightseeing trips to principal points of interest in Mexico City, a thirty-mile drive to the pyramids of Buried City of San Juan Teotihuacan, all-day water trips to Xochimilco and the Floating Gardens, to Cuernavaca, to Toluca, and to the Desert of the Lions. On the outward-bound trips the

cruise will stop at Havana, and Progreso, and returning will call again at Havana

The medical activities of the Congress will be held in the faculty rooms of the National University School of Medicine and will be divided into sections representing medicine and surgery, fractures in their various specialties, electrosurgery, fever therapy, short and ultra-short wave therapy, light therapy, massage, radium, x-ray therapy, and exercise

The officers of the Congress are Norman Edwin Titus, M D, *President*, William Bierman, M D, *First Vice-president*, Heinrich Franz Wolf, M D, *Second Vice-president*, Madge C L McGuiness, M D, *Secretary*, and Cassius Lopez de Victoria, M D, *Executive Director*

Delegates to the Congress desiring to present papers will submit the titles of their papers, together with an abstract, to either Dr Madge C L McGuiness, 1211 Madison Avenue, New York City, or Dr Cassius Lopez de Victoria, 1013 Lexington Avenue, New York City

COMMUNICATIONS

FLORIDA STATE RADIOLOGICAL SOCIETY

The regular annual meeting of the Florida State Radiological Society was held May 12, 1935, at the Harrington Hall Hotel, Ocala, Florida

This meeting was held in conjunction with that of the Florida State Medical Society. The usual round-table discussion of interesting and puzzling cases, which has been the method adopted by the Society since its inception, again proved eminently satisfactory. There were numerous visitors from the general session who made favorable comments on the character of the meeting

The following officers were elected for the ensuing year: W McL Shaw, M D, of Jacksonville, *President*; F J Payton, M D, of Miami Beach, *Vice-president*; Gerard Raap, M D, of Miami, *Secretary-Treasurer*

The next annual meeting will be held in May, 1936, in Miami. The place of the semi-annual meeting is yet to be determined

TULANE UNIVERSITY SCHOOL OF MEDICINE CELEBRATES ITS ONE HUNDREDTH ANNIVERSARY

The following communication is an abridgment of a news release received from the Secre-

tary-Treasurer of the Society. The Editor of the Journal, being head of the Department of Radiology, of Tulane University School of Medicine, was reluctant to write about the event, but, upon receiving this material from Dr Donald S Childs, he concluded that the whole country might have a certain interest in what is a matter of deep significance to the South. It is to the Editor a matter of profound satisfaction that the youngest specialty, radiology, was so honored that they chose him to act as Ivy Day Orator. Radiology is giving a good account of itself here in the South, as witness the courses of instruction offered in the leading medical schools

The sketch of the Tulane University School of Medicine celebration follows

"In commemoration of its achievement of a full century of medical and other higher education, Tulane University of Louisiana celebrated (June 8-12, 1935) with an elaborate program, including the awarding of honorary degrees to thirteen outstanding Americans, course degrees to approximately five hundred men and women, and special exercises by the various colleges and their alumni. A number of prominent speakers took part. Not only will credit be given to the Tulane School of Medicine for its notable contributions to medical research and clinical application and practice, but also for its large contribution to the health and well-being of the people of the South, Southwest, and Central America, through the 6,500 and more doctors which Tulane has graduated during the century of its existence

"Located adjoining the great, State-operated Charity Hospital, in the port city of New Orleans, equipped with the most modern and expertly planned medical plant in the South, with a faculty of more than 150 recognized medical experts, and with unexcelled facilities for practical, clinical teaching, the Tulane School of Medicine, and the Graduate School of Medicine to-day present a vivid contrast with the beginning one hundred years ago. The genesis and history of what is now the Tulane School of Medicine is most colorful. In 1833, New Orleans, then a city of only 50,000 inhabitants—with a scarcity of doctors, and no facilities for medical education—was visited by such a scourge of cholera and yellow fever that 6,000 of its people died. The seriousness of the need and the opportunity afforded by Charity Hospital for research and clinical teaching were recognized by three young physicians, Dr

Thomas Hunt, of South Carolina, Dr Warren Stone, of Vermont, and Dr John M Harrison, of Washington, D C, who had migrated to New Orleans during this epidemic. Through the energy, initiative, and persistent effort of these three immortal young men, the Medical College of Louisiana was established in the latter part of the year 1834.

"Twelve years later, in 1847, this Medical College was incorporated as the Medical Department of the University of Louisiana, which, through a grant by the State Legislature, was established in New Orleans, with the departments of Medicine, Law, and Arts and Sciences. In 1884, Paul Tulane, a resident of Princeton, N J, who had amassed a large fortune as a merchant in New Orleans before the Civil War, and who appreciated the lack of an adequate university educational system in the South, made what was in those days a princely gift of more than a million dollars to endow an institution for the higher education of the white youth of New Orleans and Louisiana. Through direct purchase, the University of Louisiana became the nucleus of the present Tulane University of Louisiana. In addition to the original three schools—Schools of Medicine, Law, Arts and Sciences—the University now includes the Graduate School, the Graduate School of Medicine, the College of Engineering, the H Sophie Newcomb Me-

morial College for Women, the College of Commerce and Business Administration, the School of Social Work, the Department of Middle American Research, and the Summer School.

"Pioneering and leading in the study of tropical diseases, the members of the Tulane Medical Faculty and alumni have made important contributions to the knowledge and control of diseases peculiar to tropical climates, such as malaria, yellow fever, cholera, beriberi, leprosy, amoebic dysentery, etc. Its graduates have achieved distinction in all branches of medicine. To mention only one—Dr Rudolph Matas, now Professor Emeritus of Surgery for his *alma mater*, has gained international renown for his contributions to the science and practice of vascular surgery. Dr Matas holds a long array of titles and honors from medical schools and medical associations throughout the world.

"The fact that New Orleans is to-day a healthy city of a half-million population, and is recognized as one of the world's outstanding medical centers, is due in great measure to the hundred years of effort of the School of Medicine of Tulane University. From every State, and from almost every country of the world, men and women have come to Tulane for a medical education.

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ACTINOMYCOSIS

The Roentgen Treatment of Actinomycosis of the Internal Organs with the Protracted Fractionated Method K. Breisländer *Röntgenpraxis*, January, 1935, 7, 35, 36

The results in the Clinic at Zürich in actinomycosis of the jaw have proved that the protracted fractionated method of irradiation marks progress in the treatment A case of an extensive actinomycosis of the anterior half of the bladder and of the mesentery proved by operation biopsy, and microscopic examination, is reported Treatment consisted of 1,560 r given over the bladder region in 13 treatments (180 K V, 2 mm Cu) The patient recovered and has remained symptom-free for two years

HANS W HEFKE, M D

APPARATUS

On the Therapeutic Importance of the Secondary β -rays Sven Benner and Björn Snellman *Acta Radiologica* 1935, 16, 233-241

The secondary β radiation from platinum filters has greater biologic effect than that from palladium filters The experimental results make it dubious whether the new Pd needles offer an advantage in treating the skin and mucous membranes The difference in the treatment of interstitial tissues with the two types of filters could not be detected

G E BURCH JR, M D

A Direction Indicator for Roentgen Tubes Magnus Strandqvist *Acta Radiologica* 1935 16, 304-309

An apparatus is described for directing roentgen tubes in the treatment of deep seated tumors through small portals The apparatus is simple and easily manipulated From the horizontal and vertical distance between the center of the tumor and the centering point in the field the tube is accurately adjusted This adjustment can be easily reproduced at each succeeding treatment

The author concludes 'In diagnostic examinations the instrument can also be used to work out standard adjustments and accurate duplications of these'

G E BURCH, JR. M D

BIOLOGIC EFFECTS

Comparison of the Effect of Roentgen Rays on Mutations in the Fruit Fly Artur Pickhan *Strahlentherapie* 1935 52, 369-388

Extensive studies of the effect of roentgen rays and radium on mutations in the fruit fly show that there is a linear relation between dose and rate of mutation Experiments carried out to determine the influence of the time factor revealed that the formula $A = I \times t$ holds for both roentgen rays and radium In contrast to some American investigators the author found that equivalent doses of roentgen rays and radium produce the same effects on mutations

ERNST A POHLE, M D Ph D

Irradiation of Chicken Embryo *in vitro* and *in vivo* with Gamma Rays of Radium C W Wilson, A F Hughes, A Glücksmann and F G Spear *Strahlentherapie* 1935, 52, 519-524

This paper was presented before the Fourth International Congress on Radiology in Zurich and can be found in English in the proceedings of the Congress

ERNST A POHLE M D, Ph D

BLOOD PRESSURE

The Effect of Irradiation on Blood Pressure S Belák and A Uhrovits *Strahlentherapie*, 1935, 52, 692-698

Following an exposure to ultra-violet rays (quartz mercury vapor lamp) the blood pressure drops first and then increases Exposures of 20 seconds have a definite effect If the exposure is repeated, it is always followed by an increase in blood pressure provided that the reaction of the first exposure has subsided Heat radiation has no definite effect If ultra-violet rays and heat are combined only a lowering of the blood pressure is observed, it seems as if the heat radiation suppresses the secondary increase of blood pressure observed after ultra-violet exposure alone

ERNST A POHLE M D, Ph D

BONE DISEASES (DIAGNOSIS)

A Contribution to the Factor of Heredity in Marble Bone Disease Alexander Pagenstecher *Röntgenpraxis* January 1935, 7, 14-16

The literature of the marble disease of bones is reviewed, especially in reference to heredity The author reports this disease in a 65-year-old farmer and his 25-year-old son In both cases the finding was accidental

HANS W HEFKE, M D

CANCER (DIAGNOSIS)

Early Diagnosis of Gastric Cancer F Schreiber-Emmer *Wien med Wchnschr* Nov 17 1934, 84, 1269 (Reprinted by permission from *British Med Jour*, March 2 1935, p 35 of *Epitome of Current Medical Literature*)

The author records several cases of carcinoma of the stomach responding satisfactorily to resection thanks to the early diagnosis, which depended on the attention paid to apparently minor symptoms In one case the first symptom was pain felt on bending there was no pain on eating the appetite was good and there was apparently no other symptom to incriminate the stomach Had the pain on bending been ignored the x-ray examination and subsequent operation would doubtless have been deferred till the case was inoperable In another case the only symptoms were loss of appetite giddiness, lassitude and some loss of weight After being treated for arteriosclerosis for four months by another practitioner the patient came to the author who was struck by the grayish yellow tint of his skin It was this tint which led to an x-ray examination and successful operation for cancer of the stomach In a third

case—that of an elderly woman—the only symptom was slight pain in the region of the left costal arch when she turned onto her left side in bed. Otherwise she felt in the ruddiest of health, and she looked perfectly well. In yet another case the only symptoms were loss of appetite and flatulence. The moral of these and several other cases is that early malignant disease of the stomach may be diagnosed by the help of the x-ray if the practitioner pays attention to seemingly trivial warnings.

CANCER (THERAPY)

The Problem of Radiation Therapy in Carcinoma of the Esophagus. Karl Wasserburger. *Strahlen therapie*, 1935, 52, 611-616.

The author studied the efficacy of radium therapy in carcinoma of the esophagus. Three to four screens containing 13.2 mg. ^{226}Ra were placed in a soft stomach tube so that a total of from 40 to 53 mg. ^{226}Ra were distributed over from 66 to 88 millimeters. The dose amounted to from 21 to 28 mc. during a period of from 70 to 80 hours with daily exposures of from 4 to 6 hours. The filter was 1.5 mm. Pt plus 2 mm. Al, the distance between radium screen and mucous membrane corresponded to approximately from 5 to 8 millimeters. Eleven out of the 27 patients admitted were treated. Some obtained temporary relief even up to the point of being able to swallow solid food. It is advisable to insert the stomach tube first without radium screens in order to test the reaction of the patient. If the manipulation is followed by a rise in temperature, it is inadvisable to start treatment. Metastatic glands require roentgen therapy. A number of roentgenograms showing the findings before and after treatment are appended.

ERNST A. POHLE, M.D., Ph.D.

Fractional or Single Massive Dose Method in the Treatment of Cancer. A. Frank. *Strahlentherapie*, 1935, 52, 602-610.

The author irradiated with roentgen rays an epithelioma of the skin 10 cm. long, 8 cm. wide and 1 cm. thick located in the right upper quadrant. One half of the tumor received 20 daily treatments of 200 r each while the other half received 1,800 r in one single dose. After the application of 1,000 r in fractional doses there was definite regression macroscopically while the half treated with the single massive dose did not show any changes. This difference in reaction was more marked after the fractional dose side had received a total of 1,800 r. Biopsies were taken of both halves of the tumor on the twelfth day and photomicrograms showing the histologic findings are appended to the paper. There are also photographs of the tumor at various intervals. On the eighty-first day following the first treatment there was still a residual tumor mass on the part which had received the single massive dose while the other half had healed. By adding 2,150 r in daily doses of from 200 to 250 r, complete healing was brought about. It is concluded therefore that the fractional dose method

is preferable in the treatment of carcinoma because the tumor disappears completely with less injury to the surrounding skin and regression begins at an earlier date than with the single massive dose method.

ERNST A. POHLE, M.D., Ph.D.

FOREIGN BODIES

Bullets in the Lung Tissue and Their Sequences. K. Ulrich. *Röntgenpraxis*, March, 1935, 7, 145-156.

Bullets were found embedded in the lung tissue without formation of a fibrous tissue capsule around them. It is very improbable that bullets may change their position in the lungs. Adhesive pleurisy, quite often with calcification, is a common sequence especially after a hemato-thorax. When cavities are formed in the lung tissue the bullets may be freely movable in them. Tuberculosis may be found independent of the injury, but may also be caused by it.

HANS W. HEFKE, M.D.

The Functional Findings and the Roentgen Diagnosis in Foreign Bodies in the Heart. M. I. Ghikin. *Röntgenpraxis*, March, 1935, 7, 185-187.

Foreign bodies in the heart are rare and their roentgenographic localization is of interest. In the case reported, the patient complained of no symptom but gave a history of a suicidal attempt. Roentgenograms of the chest and fluoroscopic examination showed a bullet in the region of the right ventricle. It moved with the pulsation of the heart, mostly up and down, and the amplitude of pulsation was about one and one half centimeters. If the mechanics of heart construction are considered it should be possible to make a correct diagnosis of the situation, of a foreign body in the heart in most cases.

HANS W. HEFKE, M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Chronic Intermittent Duodenal Stasis. Julius Friedenwald and Maurice Feldman. *Am. Jour. Roentgenol. and Rad. Ther.*, August, 1934, 32, 161-166.

The etiology of this condition may be due to (1) arterio-mesenteric compression of the duodenum, with visceroptosis, (2) movable tumors or masses producing pressure, also spinal deformity, movable growths or pressure from ptosed kidney or calcified glands, (3) adhesions and congenital bands or reflex disturbances of the duodenum from lesions elsewhere in the gastrointestinal tract, (4) stretching and sagging of the duodenum due to overloading, (5) dysfunction of the neuromuscular mechanism of the duodenum.

The greatest incidence of this condition is in middle life and in females. The symptoms are not always characteristic especially in the mild form. Frequently, however, periodic bilious attacks occur with nausea and vomiting intermittently over many years, often from childhood. Nervous strain tends to induce attacks. The onset is often preceded by constipation and headaches. Diarrhea may alternate with con-

stipation Change in posture may relieve the pain Loss of weight and strength associated with extreme exhaustion as well as mental depression and neuros-thenic symptoms may occur During an attack epigastric distress, fullness eructations of gas, and epigastric pain usually occur Occasionally pain may extend to the gall bladder region and the liver may enlarge

Roentgenologically duodenal stasis is most satisfactorily demonstrated in the upright posture In the mild cases demonstration of the disease may be very difficult Between attacks, no stasis is seen A rapidly emptying stomach by distending the duodenum may simulate the condition To eliminate this condition the duodenum must be examined at intervals over a period of at least 30 minutes In the marked cases, a 6 hour gastric and duodenal retention may be present Regurgitation into the duodenal bulb may occur The bulb may be elongated, dilated, and present a delay in the expulsion of the contrast substance In most of the cases observed, the stasis occurred in the second portion

Treatment is medical in most cases The viscerop-tosis is treated in the usual fashion and the diet is bland but so planned as to produce gain in weight Bed treatment is necessary in severe cases Surgery is employed as a last resort—either a duodeno jejunostomy or a division of constricting bands

S M ATKINS M D

Small Intestinal Invagination Caused by a Meckel's Diverticulum Egon Reiser Röntgenpraxis, February, 1935 7, 90-94

A Meckel's diverticulum had led to symptoms of small intestinal obstruction in a 34-year-old patient, causing an invagination of about ten inches of the terminal ileum The roentgenologic diagnosis had been small intestinal obstruction without showing the correct cause for it The author believes that small amounts of barium meal, given at short intervals and oft repeated roentgenograms should be employed for a more complete diagnosis

HANS W HEFKE, M D

Diverticulosis of the Colon G Bignami Arch di Radiol September October 1934 10, 517-531

Professor Bignami of Pavia points out that it is only by x ray examination that a definite diagnosis of diverticulosis of the colon can be made and gives the data on two illustrative cases

E T LEDDI M D

The Migratory Cecum Jacob Buckstein Am Jour Roentgenol and Rad Ther August, 1934 32, 171-178

The mobile cecum is due to an abnormally long mesentery and in itself is not pathological although under certain conditions, particularly as the result of kinking or axis rotation, it may produce symptoms as follows (1) intermittent colicky attacks of pain over the cecum or ascending colon without fever, (2)

chronic constipation, occasionally severe, alternating with diarrhea of short duration, (3) a tumor in the cecal region which feels as if it contained fluid and air Confirmation depends on roentgen examination, demonstrating abnormal mobility of the cecum together with dilatation and stasis within it Symptoms may also be produced by the full ptosed colon causing traction on the duodenum or gall bladder

The medical treatment consists of attention to the associated intestinal stasis and ptosis A cellulose-rich diet is contra indicated Cecal fixation is advised by surgeons

S M ATKINS, M D

GRENZ RAYS

Beneficial Effect of General Body Exposure to Grenz Rays in Severe Pain Due to a Blood Vessel nerve Tumor G Schulte and T Isselstein Strahlentherapie, 1935, 52, 646-651

The author reports an unusual case presenting numerous small extremely painful tumors of pea to walnut size distributed over various parts of the body Histologically, they appeared to be a mixture of nervous and blood vessel elements perhaps belonging to the group of glomus tumors Exposure to Grenz rays (9 K V, 10 ma 10 cm F S D, 750 r every second day) brought considerable relief A recurrence of the symptoms two years later responded again to the same treatment

ERNST A POHLE M D, Ph D

GYNECOLOGY AND OBSTETRICS

Radium Therapy in Gynecological Bleedings H Naujoks and H Hoffmann Zentralbl f Gynäk, Aug 18, 1934 58, 1922-1935 (Reprinted by permission from British Med Jour, Dec 8, 1934, p 88 of Epitome of Current Medical Literature)

The authors report that at the Marburg Universitäts-Frauenklinik radium treatment plays an increasing part in the therapy of metrostaxis due to benign disease, and in this connection has almost completely replaced x radiation The great majority of cases of 'non malignant bleeding' which are treated by radium are those of women over 40 who have menorrhagia or metrorrhagia in the absence of any important morbid physical findings on bimanual examination pathologically they fall in the groups of chronic induration, myomatosis metropathia hemorrhagica or glandulocystic hyperplasia Together with 252 cases of this description radium treatment was given for 'benignant bleedings' in 25 cases of myoma (including six of submucous myoma), two of blood disease with severe metrorrhagia two of severe bleedings of puberty and two of therapeutic sterilization At Marburg operative treatment of myoma is the rule radium therapy being reserved for occasional cases of very small myomas or as a life saving measure (because of the very prompt stoppage of the bleeding) in exceptionally blanched patients with large myomas In bleeding at puberty radium is required—very very rarely—as an alternative to hysterectomy in critical cases in both the patients treated by radium the menses returned after a few

months. The application of the radium within the uterus, in a single dose of 50 mg applied for twenty-four to forty-eight hours, is preceded immediately by curetting and is never undertaken unless careful clinical examination has shown signs of inflammation, such as pyrexia, and abnormal erythrocyte sedimentation time to be absent. In seven instances of 285 the histological examination of the curettings showed a carcinoma of the corpus uteri; a second radium application was given a few days later and followed by γ -radiation, and cure appeared to be attained in all.

In the very great majority of cases of "non malignant bleeding" the radium treatment had a prompt and satisfactory result, three-quarters ceasing to bleed after the radiation and nearly a quarter having only one more hemorrhage. One lethal case (from embolus), one abscess in the pouch of Douglas, and one femoral thrombosis were the total morbidity findings after 285 applications of radium. Menopausal symptoms were not severe.

The mode of action of radium in these "non malignant bleedings" is not clear. While not denying the possibility of ovarian affection, especially with large doses, Naujoks and Hoffmann are inclined from the results of tests for folliculin and antuitrin in the blood to look on the treatment as affecting chiefly the uterus of which the lining is known to become structureless and necrotic without the cavity being obliterated.

Roentgen-ray Dosimetry in the "Third Dimension" in Gynecology. F. Friedl. *Strahlentherapie*, 1935, 52, 664-670.

The author discusses the various technics used in gynecologic radiation therapy. For carcinoma of the cervix he recommends one anterior, one posterior, and two lateral fields of 15×10 cm. and in some cases a vulva field is added. The dose effective in the tumor is 600 r. Preceding the first roentgen treatment he administers 30 mg. ra. to give a dose of 1,000 mg.-hr. in the cervix, and 60 mg. ra. in the vagina to give there a total dose of 2,000 mg. hr. filtered through 3 mm. Pb or its equivalent in one sitting. Three weeks after this first radium treatment a second application is given while roentgen therapy is repeated three months later. Roentgen sterilization is best carried out with one large anterior and posterior field and 300 r effective in the ovaries.

ERNST A. POHLE, M.D., Ph.D.

X-rays in Obstetrics. K. Heyrowsky. *Med. Klin.* Dec. 7, 1934, 30, 1630-1632. (Reprinted by permission from *British Med. Jour.* March 30, 1935, p. 54 of *Epitome of Current Medical Literature*.)

The author, in discussing the indications for γ rays in obstetrics, states that they are required only in rare cases when all other diagnostic methods have failed. When γ -ray plates are necessary they can be taken without any discomfort to the patient under strictly aseptic conditions and without the slightest fear of danger to the fetus. A plate taken in the coronal plane is of relatively little value except when there is a suspicion of

plural births, death of the fetus, and fetal malformations. The author has frequently diagnosed the latter in the presence of hydramnios, especially when indistinct fetal heart sounds could be heard but no movements could be felt. A plate in the sagittal plane is of more value as in it the relation of the fetal head to the pelvis may be estimated. It is indicated in contracted funnel shaped, and rickety flat pelvises in spondylolysis and spondylolisthesis. An axial exposure, which is technically a difficult procedure, gives the best results when the pelvis is obliquely contracted or asymmetrical. For a correct estimation of the degree of flexion lateral and dorso-ventral plates are required. X rays are valueless in determining the actual measurements of the fetal head.

Editor's Note—This is not in agreement with opinion in this country.

HAY FEVER

Experience in the Treatment of Hay Fever and Rhinitis Vasomotoria. Lilly Pokorny. *Strahlen therapie*, 1935, 52, 656-659.

The author reports six cases of hay fever and rhinitis vasomotoria which were treated by roentgen rays. Technic: 220 r. through 0.2 mm. Cu plus 1 mm. Al over the nose in adults; in children the dose is less according to the age, the interval between series four weeks. Five of the patients were cured.

ERNST A. POHLE, M.D., Ph.D.

HEART AND VASCULAR SYSTEM

The Roentgen Diagnosis of Atherosclerosis of the Thoracic Aorta. A. Baranova. *Röntgenpraxis*, March, 1935, 7, 175-182.

Dilatation and tortuosity of the aortic shadow change in the character of the pulsation, and greater intensity of the aortic shadow have been generally considered diagnostic for atherosclerosis of the aorta.

The widening and elongation of the aorta may be caused by different pathologic processes. The changes of old age alone may cause them, as well as a change in the character of pulsation. These roentgenologic symptoms do not allow a differentiation between atherosclerosis and loss of elasticity due to old age.

The third symptom, that of greater intensity of the aortic shadow, has been studied by the author. By making roentgenograms of pieces of different aortas from autopsy material the different stages of atherosclerosis were examined. There was no appreciable difference in the intensity of the shadows. Only when there were calcium deposits these areas were increased in density but only in isolated spots. The roentgenologic symptom of a diffuse intensification of the shadow of the aorta is therefore unreliable as far as the diagnosis of atherosclerosis is concerned. The finding of calcified areas or plaques is of roentgenologic significance only. The difference in the intensity of the aortic shadow rather is determined by its diameter and factors which influence the intensity of the surrounding areas.

HANS W. HEFKE, M.D.

Aneurysm of the Abdominal Aorta Werner Hollmann *Röntgenpraxis*, December, 1934, 6, 811-814

Aneurysms of the abdominal aorta are very difficult to diagnose clinically, roentgenologically, a diagnosis is possible only by effects of the aneurysm on neighboring organs especially erosion of the spine. The anterior aspects of the twelfth dorsal and first lumbar vertebrae in this case show a halfmoon like destruction, to the left of the spine there were some areas of calcification. The thoracic aorta showed roentgenologic signs of a syphilitic aortitis. The positive Wassermann reaction and the roentgenologic signs suggested the diagnosis of an aneurysm of the abdominal aorta. Clinically there were angio-spastic pains and neuralgic pains in both legs which made the patient bedridden. Treatment with iodine and mercury improved the patient so much that he was able to be up and about again.

HANS W HEFKE, M D

A Typical Case of Aneurysm of the Heart H Regelsberger *Röntgenpraxis*, December, 1934, 6, 806-811

Clinically diagnosed and roentgenologically demonstrated, aneurysms of the heart itself are as yet rare in the medical literature. Such a case is reported with autopsy findings. There was a sac like fairly well circumscribed bulging at the left border of the heart, which corresponded with the position and size of the aneurysm at the autopsy.

HANS W HEFKE, M D

Cardiospasm or Hiatus spasm (?) Theodor Bársony and Ernst Koppenstein *Röntgenpraxis* February 1935 7, 73-79

There is spastic narrowing of the cardia as well as of the hiatus when one speaks of functional cardiospasm. A definite localization of the spasm is possible roentgenologically in the greatest number of cases. The differentiation between the two places of constriction is necessary, especially when surgical intervention seems indicated.

HANS W HEFKE, M D

THE HIP JOINT

Otto's Disease and Other Forms of Protrusio Acetabuli Kristian Overgaard *Acta Radiologica* 1935, 16, 390-410

The term "protrusio acetabuli" has been applied to a number of cases of deformities of the pelvis the common feature being a protrusion of the acetabulum more or less deeply into the lumen of the small pelvis associated with a medial displacement of the contents of the hip joint. This condition was first described in 1824 by A W Otto who reported a case of bilateral protrusion of the hip-sockets.

A careful survey of the literature and of his own cases has convinced the author that these cases fall naturally into two large and one smaller third group.

The first group designated as "secondary protrusions" comprises those cases in which it may be di-

rectly inferred from the history or from the specimen that there has been a clearly traceable focal destructive disease in the socket of the diseased hip joint, or a trauma. In these cases, the disease, as a rule, appears only on one side, and the protrusion must be regarded as a direct consequence of the destructive process and the subsequent healing.

The second group includes those cases of true "Otto's disease" and has been called "osteo-arthritis protrusions." In these cases the condition appears without a traceable focal disease is usually bilateral and limited to the acetabulum itself. It has been regarded as a special form of the deforming osteo arthritis of the hip joint. A certain form of development of the hip socket is thought to be a contributive factor, or the chief cause of the development of the disease. The onset of the condition is usually insidious and protracted and frequently the deformity appears as an accidental discovery.

The third and smallest group has been classified as "juvenile osteo-asthenic protrusions." This disease occurs in young women at about the age of puberty. There are no evidences of previous focal disease or trauma of the hip joint. It is believed to result from a lessened resistance of the bone tissue.

The author reports 13 new cases illustrating the three types of protrusio acetabuli.

J N ANÉ, M D

INFLAMMATORY DISEASES

Indications of Roentgen Therapy in Non malignant Ano rectal Disease Bensaude, Solomon, and Marchand *Strahlentherapie* 1935, 52, 660-663

The authors have observed good results in the treatment of fistula, fissura ani, and thrombosis in hemorrhoids. From 150 to 225 r are given per sitting up to total doses of from 1,400 to 2 000 r. It is advisable to use heavy filtration. In pruritus ani, condyloma, and inflammatory processes of the rectum good results may also be obtained.

ERNST A POHLE, M D, Ph D

The Experimental Foundations of Roentgen Therapy in Acute Inflammatory Disease J P Mischtschenko, M M Fomenko, T F Feszenko, S N Ledanow, and A W Morgatschow *Strahlentherapie* 1935, 52, 464-496

It is well known clinically that the roentgen ray has a beneficial effect in many cases of inflammatory disease, however its mechanism is still unknown. The authors undertook, therefore a series of clinical morphological, serobacteriological, chemical, and physico-chemical studies in order to shed some light on this problem. They found that the optimal dose in rabbits was 80 per cent H E D, in guinea pigs, 60 per cent H E D and in man from 20 to 30 per cent H E D (the latter corresponds probably to from 120-180 r). During the initial stage of inflammation, higher doses may be required. Studies of the blood and the local cell reaction showed that there is an increase in the decomposition of leukocytes and also in the phagocytosis

following irradiation. In all probability non specific antibodies are formed. Aminoacids and trypsin are increased following irradiation. No reaction could be found in the small blood vessels as studied on the ear of the rabbit. The analgesic effect of roentgen rays in inflammatory diseases may be due to the influence of decomposed proteins and lipoids on the nerve ends.

ERNST A. POHLE, M.D., Ph.D.

THE KNEE JOINT

Pellegrini-Stieda's Disease (Post traumatic Calcification of the Collateral Tibial Ligament of the Knee) Max. Ritvo and Joseph Resnik. *Am Jour Roentgenol and Rad Ther.*, August 1934, 32, 189-195.

Pellegrini-Stieda's disease is a post-traumatic calcium deposit in the region of the collateral tibial ligament of the knee, and roentgenologically is seen medial to the inner condyle of the femur. The calcification is not visible until two weeks or more after the injury, therefore, repeated roentgen studies are necessary. Pellegrini made the first report in 1905 and Stieda, independently, in 1908.

This condition may be produced by direct or indirect trauma severe or slight. Microscopically the calcified mass is definitely bony in character. Directly following the trauma the symptoms are those following injury to the knee, but they fail to subside. In those of months or years' duration there is limitation of motion of the knee joint. A sense of resistance and thickening is present over the inner aspect of the knee. The mass may be palpable and slightly movable. Tenderness is not necessarily present in the late stages.

Roentgenologically the mass is usually a semilunar calcification just medial to the inner condyle of the femur, but the shape and size may vary and enlarges as disease progresses. The older the condition, the denser it becomes. There is never any connection to the femur. This is an important differential point.

Treatment in the acute stage consists of rest and physiotherapy, as in subdeltoid bursitis and, if this fails, surgery is advised. Reports on 11 of the authors' cases are included.

S. M. ATKINS, M.D.

THE LUNGS

The Situation of the Pleural Exudate in Obstructive Atelectasis of the Lung. Nils Westermark. *Acta Radiologica*, 1935, 16, 345-353.

The author reports 13 additional cases of paradoxical situation of free pleural exudate associated with massive collapse of the lung. Jacobæus and the author have previously reported five cases of the same condition in which the occlusion which led to the massive pulmonary collapse was due to bronchial cancer. In the present series of 13 cases, bronchial occlusion resulted from bronchial cancer in six cases, from tuberculosis in four cases, from pleuro-pneumonia and bronchiectasis in two cases, and from trauma in the lung in one case. In the 18 cases observed by the author the free exudate had a sharp upper border which extended

obliquely laterally and downward instead of, as usual, obliquely medially and downward.

The situation of the free pleural exudate was found to vary, depending particularly on the site of the obstructive atelectasis and to a certain extent on the amount of exudate and atelectasis and their relation to one another. When the atelectasis was noted in the lower and middle lobes or in the anterior inferior part of the left upper lobe, the exudate was always situated near the atelectasis. With atelectasis of the posterior medial portion of the lower lobe, the exudate lay posteriorly and medially. With atelectatic involvement of the middle lobe or lower part of the left upper lobe, the exudate was found anteriorly and medially. When the shadow of the exudate partially or completely covers the area of obstructive atelectasis a determination of the position of the exudate enables one to diagnose the site of the atelectasis and thus of the one or more occluded bronchi.

In the author's opinion the situation of the free pleural exudate is determined by the following factors: (1) the weight of the exudate, (2) the compressibility of the surrounding tissues especially of the lungs, (3) the reactivity of the lung, and (4) the pressure conditions within the pleural cavity. It is believed that the lung has its greatest reactivity in the periphery far from the hilum. It, therefore, follows that the basal lateral and posterior portions of the lower lobe are the most compressible and have the greatest power of retraction in the normal lung. With the patient in an upright position the exudate in the case of the normal lung is situated inferiorly laterally and posteriorly and gives the picture of a massive density which on a frontal view has an upper border running obliquely medially and downward. On the lateral view the exudate is situated mainly posteriorly and has a border which passes obliquely anteriorly and downward. These findings however are dependent upon the preservation of the normal elasticity and negative pressure in the pleural cavity. If that elasticity is interfered with for any reason or the negative intrapleural pressure changed, the roentgen appearance of the fluid will take on a different form.

In an obstructive atelectasis in a case in which the medial portions of the lung close to the hilum are collapsed and retracted, the exudate must take a corresponding position as the reactivity is greatest in these portions. When obstructive atelectasis occurs in the lower and middle lobes the exudate is situated close to the collapsed parts as these lobes are retracted and have the greatest capacity of retraction. In the case of obstructive atelectasis of the upper lobe the volume of the upper parts of the lung is decreased and the decrease is compensated for by the expansion of the aerated portions. When an exudate develops these expanded portions of the lung are first reduced to their normal size before they are compressed. The exudate must then first lie under the lower lobe before the latter is compressed. The lower lobe will then float on the exudate and leave more room medially than laterally so that most of the exudate is situated

medially With an increase in the volume of exudate the lower lobe will become compressed, first along the lateral posterior parts as in normal cases, and the exudate will then also lie laterally and posteriorly

The author suggests the employment of diagnostic pneumothorax, and roentgenograms with the patient in other positions to establish the diagnosis of pleural exudate associated with obstructive atelectasis

J N ANÉ M D

The Frequency of the Finding of Fine Pleural Shadows in the Roentgenograms of Lungs of Children, and Their Dependence on the Roentgenologic Technic L Schall and H Weil Röntgenpraxis December, 1934 6, 801-803

The rather frequent finding of fine hair like shadows, representing parts of the pleura, in children's chest roentgenograms is dependent on the progress in roentgen technic Different authors could demonstrate them in different percentages of cases It seems questionable if any pathologic significance can be attributed to these shadows, in many cases the normal pleura may be shown under ideal conditions of projection and with the best technic These hair-like shadows were not seen more often in children with a positive tuberculin test than in tuberculin negative children

HANS W HEFKE M D

Further Experience with Roentgen Therapy in Malignant Neoplasms of Bronchus and Lungs G Herrnhaiser Strahlentherapie 1935 52, 425-459

In a previous publication the author has urged the use of x ray deep therapy in malignant tumors of the lungs and bronchi He analyzes in this article 16 cases of that type treated since 1931 five were still alive at the time of the report Numerous tables are appended giving the details of the clinical history and particularly all data regarding the treatment technic While it will be necessary to refer to the original for that information it may be stated that a total surface dose of 9 000 r is required to bring about regression of this type of tumor Technic 170 K V, 1.2-2.0 mm Cu 40 cm FSD, 150-200 cm sq field 1 anterior 1 posterior and sometimes 1 lateral field 300-400 r per field per sitting

ERNST A POHLE M D, Ph D

Diagnosis of Congenital Cysts of the Lung C de Lange and M de Bruin Nederl tijdschr v geneesk, Nov 10 1934 78, 5127-5136 (Reprinted by permission from British Med Jour March 2 1935, p 35 of Epitome of Current Medical Literature)

The authors who record three illustrative cases state that until recently congenital cysts of the lung were regarded as a very rare occurrence During the last few years however there has been a great increase in the number of cases published Sometimes no symptoms are present so that the condition is found accidentally in the course of physical examination In most cases however there has been some shortness of breath since birth and the patient has suffered on several occasions from bronchitis or pneumonia The most important

symptom is the occurrence of violent attacks of dyspnea usually accompanied by cyanosis lasting from a few hours to a few days

As regards physical signs multiple small cysts present the appearance of bronchiectasis while one or more large cysts show the signs of pneumothorax with occasionally considerable displacement of the heart and mediastinum to the healthy side The diagnosis can usually be made by x ray examination The prognosis is probably not so bad as the older writers would lead one to expect

As regards treatment the question must be considered as to whether puncture of the cyst is desirable in those cases in which physical and x ray examination has shown that there is a considerably increased pressure in the cyst In most cases however puncture of the cyst followed by permanent drainage is indicated

An Infected Cystic Lung Erich Zdansky Röntgenpraxis, February, 1935, 7, 79-85

Multiple cysts of the lung are either congenital or due to bronchiectases acquired in childhood The roentgenologic appearance is markedly characteristic The patients suffer often from complicating attacks of bronchitis Horizontal fluid levels may indicate the presence of secretion When the lung tissue becomes infected roentgenograms show areas of infiltration around the cysts pleuritic thickening and secondary bronchiectasis It seems certain that this anomaly is by no means always harmless to the patient

HANS W HEFKE, M D

THE PROSTATE

Prostatic Calculi L H Baretz Urol and Cutan Rev, October 1934 38, 703-706 (Reprinted by permission from British Med Jour Jan 26 1935 p 16 of Epitome of Current Medical Literature)

The author who records an illustrative case states that prostatic calculi are not uncommon According to Kretschmer they are most frequently found in the fifth decade the youngest in his series being a man of 21 and the oldest one aged 76 Venereal disease plays only a minor part in their causation Their average number is five to ten and their average size from one-sixteenth to one eighth inch They are usually brown or brownish black in color and frequently have an iridescent sheen The outer layers generally consist of calcium phosphate or other earthy salts such as ammonio-magnesium phosphate and calcium carbonate Occasionally urates and oxalates are found The ordinary symptoms are perineal or rectal discomfort urgency frequency, and difficulty in micturition Symptoms of an associated prostatic hypertrophy may be present Sometimes there are no symptoms at all

The diagnosis is established by rectal examination and x-rays In mild cases prostatic massage is indicated, as it may express a small calculus into the urethra In severe cases operation by the perineal or suprapubic route is required Baretz's case was that of a man aged 65 from whom more than 180 prostatic calculi and enlarged prostatic lobes were removed by suprapubic cystotomy

following irradiation. In all probability non specific antibodies are formed. Aminoacids and trypsin are increased following irradiation. No reaction could be found in the small blood vessels as studied on the ear of the rabbit. The analgesic effect of roentgen rays in inflammatory diseases may be due to the influence of decomposed proteins and lipoids on the nerve ends.

ERNST A. POHLE, M.D., Ph.D.

THE KNEE JOINT

Pellegrini-Stieda's Disease (Post traumatic Calcification of the Collateral Tibial Ligament of the Knee) Max Ritvo and Joseph Resnik. *Am Jour Roentgenol and Rad Ther* August, 1934, 32, 189-195

Pellegrini-Stieda's disease is a post traumatic calcium deposit in the region of the collateral tibial ligament of the knee and roentgenologically is seen medial to the inner condyle of the femur. The calcification is not visible until two weeks or more after the injury, therefore, repeated roentgen studies are necessary. Pellegrini made the first report in 1905 and Stieda, independently, in 1908.

This condition may be produced by direct or indirect trauma, severe or slight. Microscopically, the calcified mass is definitely bony in character. Directly following the trauma the symptoms are those following injury to the knee but they fail to subside. In those of months or years' duration there is limitation of motion of the knee joint. A sense of resistance and thickening is present over the inner aspect of the knee. The mass may be palpable and slightly movable. Tenderness is not necessarily present in the late stages.

Roentgenologically the mass is usually a semilunar calcification just medial to the inner condyle of the femur, but the shape and size may vary and enlarges as disease progresses. The older the condition, the denser it becomes. There is never any connection to the femur. This is an important differential point.

Treatment in the acute stage consists of rest and physiotherapy, as in subdeltoid bursitis, and, if this fails surgery is advised. Reports on 11 of the authors' cases are included.

S. M. ATKINS, M.D.

THE LUNGS

The Situation of the Pleural Exudate in Obstructive Atelectasis of the Lung. Nils Westermark. *Acta Radiologica*, 1935, 16, 345-353

The author reports 13 additional cases of paradoxical situation of free pleural exudate associated with massive collapse of the lung. Jacobæus and the author have previously reported five cases of the same condition in which the occlusion which led to the massive pulmonary collapse was due to bronchial cancer. In the present series of 13 cases, bronchial occlusion resulted from bronchial cancer in six cases, from tuberculosis in four cases, from pleuro-pneumonia and bronchiectasis in two cases and from trauma in the lung in one case. In the 18 cases observed by the author the free exudate had a sharp upper border which extended

obliquely laterally and downward instead of, as usual, obliquely medially and downward.

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The author regards the presence or absence of metastatic nodes as important as the gross and microscopic characteristics of the lesion in outlining treatment for an epithelioma of the skin. If nodes are present he favors diathermic coagulation followed at once by roentgen rays, otherwise, diathermy alone can be used. This method of treatment has given satisfactory results over a period of two years.

E T LEDDY, M D

THE SKULL

Interpretation of Ventriculograms with Special Reference to Tumors of the Temporal Lobe. A Torkildsen and A H Pirie. *Am Jour Roentgenol and Rad Ther* August, 1934, 32, 145-153.

In encephalography the authors inject in the third or fourth lumbar interspace, with the patient in a sitting position, and routinely take the following views: anteroposterior, with the brow up, lateral, with the brow up, stereoscopic films with right and left side up, one postero anterior with occiput up, lateral with occiput up, and anteroposterior with forehead up. One of the two anteroposteriors is given a shorter development, to demonstrate the lighter shadows caused by the anterior horns. The patient's head must be maneuvered so that the gas fills the parts of the ventricles to be shown.

The lateral ventricle is divided arbitrarily into six portions which can be recognized in the antero-posterior view. The lateral view shows the upper outline of the lateral ventricle following the outline of the skull in a dolichocephalic it is less curved than that of a brachycephalic.

In tumors of the temporal lobe both lateral ventricles are pushed to the opposite side for a considerable degree. The upper part of the third is likewise displaced, but the lower part remains anchored to the mid line with a concavity toward the tumor. Dilation of the lateral ventricles and sometimes of the third occurs on the side opposite the neoplasm and compression on the same side. The anterior horn is unaffected. The ventricle of the affected side is lower than its fellow and the roof appears flattened, even concave at times. The descending horn of the affected side is compressed early and if seen is pushed upward and toward the opposite side. Very instructive drawings and roentgenograms accompany this paper.

S M ATKINS M D

Treatment of Basal Fractures of the Skull. Hesse. *Münch med Wchnschr* Oct 19, 1934 81, 1605-1608 (Reprinted by permission from *British Med Jour*, Feb 2 1935 p 20 of *Epitome of Current Medical Literature*).

The author writing from the standpoint of an otorhinologist expresses the following views concerning treatment of fractures of the base of the skull. Conservative treatment in the presence of fractures involving the aural nasal or accessory nasal cavities is fraught with very considerable risk of a late meningitis which is almost invariably fatal. Accordingly a special rhinoscopic and otoscopic investigation should be done in the

early stage and x ray films should be made from the appropriate special angles when fractures of the middle ear, petrous-temporal, or accessory sinuses seem likely. Not all basal fractures are to be detected radiologically especially those of the roof of the ethmoid, the posterior wall of the frontal sinus, or the roof of the sphenoid. In general, prophylactic operation (exploration and clearing) should be done in comminuted or splinter fractures involving the ear or nasal cavities. In clean-cut fractures near the internal ear expectant treatment is justified except (1) when chronic suppuration of the ear antedates the accident or (2) when the fracture opens into the middle ear. Clean-cut fractures involving the roof or posterior wall of the accessory nasal sinuses justify operation, for intracranial infection is then easier than in fractures affecting the ear. X-ray proof of veiling of the frontal ethmoidal or sphenoidal sinuses indicates the possible combination of effusion of blood with small basal fissures, opening of the sinus by draining the hematoma will prevent its suppuration. On the whole Hesse does not doubt that it is considerably less dangerous in the cases mentioned to open up to the fracture from the temporal zone or from the accessory sinuses than to risk the late onset of serious intracranial complications.

Form Size and Position of the Maxillary Sinus at Various Ages Studied by Means of Roentgenograms of the Skull. H Jobe Sedwick. *Am Jour Roentgenol and Rad Ther*, August, 1934 32, 154-160.

A detailed study of the size, shape, position variation, and measurements of the maxillary sinuses at various ages was made roentgenologically. Of the group examined 80 were triangular 42 oval, 33 irregular, 9 oblong and 9, square. The sizes shapes and positions varied not only in different individuals but in each side of the same individual. The sinus makes its appearance about the tenth week of fetal life and reaches the maximum size during the third decade of life and does not increase thereafter.

S M ATKINS M D

THE STOMACH

The Stomach and Duodenum after Operation. S Cochrane Shanks. *British Med Jour* Dec 8, 1934 No 3857, 1032-1037.

The stomach and duodenum after operation present on roentgen examination many normal variations which must be differentiated from pathologic conditions. The screen examination and the demonstration of the mucosal relief pattern assume even greater importance than in the examination of the intact stomach. Of great assistance is the operative record of the precise type of surgical procedure performed on each case.

The author has divided these post-operative cases from a radiographic point of view into three general classes as follows: (1) sphincteric control retained (2) sphincteric control partly retained (3) sphincteric control abolished. In the group with retention of

RADIATION EFFECTS

Blood Disease as a Result of Irradiation Heinz N Brinnitzer *Strahlentherapie*, 1935, 52, 699

The author presents a brief compilation of the various effects of roentgen rays and radio active substances on the blood, including the blood diseases caused by irradiation. It is arranged under the following headings: Biologic effect of roentgen rays on blood and blood forming organs in experimental animals and in man, blood changes in professional workers and blood diseases caused by irradiation, blood changes following therapeutic exposures, aggravation of polycythemia following roentgen treatment. A very complete bibliography is appended.

ERNST A POHLE, M D, Ph D

The Biologic Systemic Effect of Irradiation R Reding *Strahlentherapie* 1935, 52, 545-601

This is a critical review of the literature dealing with the systemic effect of roentgen rays. Changes in the blood sugar, pH, calcium and other minerals, lactic acid, lipoids, nitrogen metabolism, reticulo-endothelial system, the autonomic nerve system, and the blood are considered. While this paper is not suitable for a brief abstract, it is recommended for study in the original because it gives a good conception of the present status of our knowledge. An extensive bibliography is appended.

ERNST A POHLE, M D, Ph D

RADIUM

Results of Radium Irradiation of Blood Vessels in Circulatory Disturbances Wilhelm Schloss *Strahlen therapie* 1935 52, 652-655

The author treated 150 patients with circulatory disturbances. 138 were males and 12, females. There were 68 cases of intermittent claudication, 30 cases of endarteritis obliterans, 25 cases of arteriosclerosis and 27 cases of diabetic gangrene. Superficial radium application was followed by disappearance of the symptoms in 40 cases while 12 were improved but only temporarily relieved from symptoms. 46 were improved permanently, 12 temporarily and 40 were not benefited. The hypothesis is advanced that irradiation produces a hormone called 'menformon', it has been shown by Snapper that this hormone improves the circulation in both men and women.

ERNST A POHLE, M D, Ph D

The Dose Distribution in a Circular Surface Applicator H D Griffith and Karl G Zimmer *Strahlentherapie*, 1935 52, 671

The authors calculated the distribution of radiant energy from a circular radium applicator and compared it with the values obtained by means of an ionization chamber (Sievert condenser type). After certain corrections were made the two values agreed fairly well.

A method is described which permits a homogeneous intensity distribution.

ERNST A POHLE, M D, Ph D

RESPIRATORY TRACT

Bronchography A Beutel *Röntgenpraxis*, March 1935, 7, 157-167

The author says that 40 per cent iodipin (Merck) or lipiodol (Lafay) is used for bronchography. If an idiosyncrasy against iodine exists, a bromide-oil mixture may be used. Transglottic injection is the best and simplest method. In more than 500 bronchographies done by the author there has been no complication except occasionally a slight rise in temperature. The trachea may be investigated also by this method. A case of papillomatosis of the trachea is described, the first one to be diagnosed roentgenologically.

Bronchiectases are the most frequent indications for bronchography, and important from a diagnostic standpoint in that bronchiectases which are not visible in flat films may be shown by this method. Exact localization and determination of the extent of the bronchiectases may be found only by this method when clinical examination, because of hemoptysis is negative. In other cases the clinical diagnosis may be bronchiectasis, but a bronchography shows no evidence of that disease and the diagnosis must then be putrid bronchitis. Cylindrical bronchiectasis shows the picture of a tree without leaves because there is no alveolar filling. Club like bronchiectases are much like the saccular type. These are either completely filled or may show a fluid level. Large bronchiectatic cavities may be single or multiple and are often hidden behind liver or heart on flat films. In bronchiectases as in larger cavities a lipiodol-filling may occasionally not take place when the bronchus is occluded by secretion, blood, etc. A cystic lung has been described by the author.

Bronchography is of comparatively small value for the diagnosis of abscess cavities, plain roentgenograms are usually sufficient.

For the exact localization of fistulas, the injection of contrast material is of great value, but one must remember that non filling does not mean non-existence of a fistulous tract. Esophageal-bronchial fistulas are usually discovered by giving a barium meal, next in frequency are bronchopleural fistulas.

Extrabronchial expansive processes may compress or displace parts of a bronchus, and bronchograms are occasionally of diagnostic help.

Intrabronchial tumors may show no changes on flat chest films. A bronchogram often allows an easy diagnosis. Several illustrations show the different types of bronchial tumors.

HANS W HEFKE M D

THE SKIN

Physical Therapy of Cutaneous Epithelioma Bruno Faccini *Arch di Radiol*, September-October 1934 10, 553-563

found in the fifth and sixth decade, a roentgen examination should be made immediately. The absence of free hydrochloric acid is not pathognomonic. 50 per cent of the cases showed free hydrochloric acid in a group reported by Hartment of the Mayo Clinic. Only 25 per cent of cancers of the stomach are operable when first diagnosed. In a group of 278 cases of the operable type, with no lymphatic involvement, a 5-year cure was obtained by Balfour in 50 per cent.

S. M. ATKINS, M.D.

SYMPATHETIC NERVOUS SYSTEM

Roentgen Therapy of the Sympathetic Nervous System. Delherm and Beau. *Strahlentherapie*, 1935, 52, 629-645.

Exposure of parts of the sympathetic nervous system may be beneficial in a number of diseases. In pruritus ani and vulvæ the local area receives 1 H. per field (80 K.V., 5 mm. Al.) until the total dose reaches 1,000 R.¹ The sacral area is exposed in the same manner with 120 K.V. through 8 mm. Al. In a number of skin diseases, as for instance, lichen vitiligo, psoriasis, warts, eczema, keloids and certain forms of lupus, exposure of the spine (D 4, L 3, and L 4, ganglion stellatum) and the involved area with 500 R. through 0.5 Al. are recommended. In vasomotor disturbances and Reynaud's disease the authors used a radiation of moderate penetration directed to the cervical and upper dorsal spine for upper extremities and to D 10 to L 5 for the lower extremities. The plexus for each area is also exposed. The filtration varies from 2 to 8 mm. Al. and the doses amount to from 400 to 500 R. per sitting up to a total dose of from 1,500 to 2,000 R. There is an interval of six weeks between series. In angina pectoris an exposure of the heart and aorta including the ganglion stellatum to irradiation of moderate penetration is often helpful. The dose is from 300 to 500 R. per sitting; there are three sittings per week with a total dose of from 3,000 to 5,000 R. per field. Hypertension is treated according to the technic of Zimmerman and Cottenot by exposing the adrenals. In arteritis obliterans the upper or lower spine is exposed depending on whether the upper or lower extremities are involved. Technic: 100-180 K.V., 5 mm. Al. or 0.25 mm. Zn. once or twice a dose per week which may be repeated six times. In a series of 34 cases there were 33.3 per cent cures, 33.3 per cent improvements and 33.4 per cent failures. In addition to the treatment of the spine the peripheral plexus is also exposed. In asthma and hay fever good results were observed after exposure of the mediastinum and the spleen. 500 R. are given every second day up to a total dose of 3,000 R. In whooping cough irradiation of the mediastinum may also be beneficial. Well recognized is the use of roentgen rays in the treatment of herpes zoster, both the spine as well as the involved area may be exposed. In syringomyelia and

tubercles, good results—at least temporarily—may be expected. In a number of endocrine disturbances, roentgen rays can also be of value as a supplementary treatment. In the last part of the article the blood changes seen following irradiation as well as some of the experimental results concerning the effect of roentgen rays on the sympathetic nervous system are briefly recorded.

ERNST A. POHLE, M.D., Ph.D.

THE TONSILS

Roentgen Therapy of Tonsillitis. E. D. Dubowyn and I. K. Lusers. *Röntgenpraxis*, December 1934, 6, 815-817.

Fifty patients suffering from tonsillitis have been treated by the authors with roentgen rays (210 K.V. 4 ma. 0.5 mm. Cu. and 2 mm. Al.). A skin focus distance of 25 cm. was used, the field applied just below the angle of the mandible measured 5 × 6 cm., 100 r. were given to each field. The average patient reacted with an increase in temperature and symptoms during the first 24 hours after the treatment. The day following the treatment there was definite improvement, subjectively and objectively. In two cases of a tonsillar phlegmon the improvement was slower and an abscess formed. While patients with a follicular tonsillitis are usually unable to work for from three to six days, the time of disabling sickness is usually cut down to one or two days, exceptionally three to four days, after roentgen treatment.

In 90 per cent of chronic recurrent tonsillitis there was complete and lasting relief from x-ray therapy. Complications due to the treatment with roentgen rays were not noted.

HANS W. HEFKE, M.D.

TUBERCULOSIS, PULMONARY

Intestinal Tuberculosis of the Ulcerating or Cicatrizing Type and its Relationship to Pulmonary Tuberculosis. Giovanni da Empoli. *Arch. di Radiol.*, September-October 1934, 10, 481-516.

In the Istituto Diagnostico di Reggio Calabria there have been carried out for some years systematic roentgenologic gastro-intestinal examinations of patients with pulmonary tuberculosis. In this investigation a high incidence of gastro-intestinal involvement has been found. The author here reports a detailed study made on four such patients and from it he emphasizes the value and importance of roentgenologic examination.

E. T. LEDDI, M.D.

TUMORS (DIAGNOSIS)

Present Status of Diagnosis of Renal Tumors. B. H. Nichols. *Am. Jour. Roentgenol. and Rad. Ther.*, December 1934, 32, 769-781. (Reprinted by permission from *British Med. Jour.*, March 2, 1935, p. 37 of *Epitome of Current Medical Literature*.)

¹ Doses expressed in this article are in French R., 2.2 French R. correspond to 1 international r.

sphincteric control the radiographic technic is much the same as in the examination of the intact stomach, except that special attention should be paid to the relief pattern. In some of the cases in which only partial sphincteric control exists and in all of the cases in which sphincteric control is abolished, some method of pressure must be used to occlude the efferent jejunal loop and prevent rapid emptying of the stomach. To accomplish this the author has devised an adjustable truss which consists of a leather-covered spring band, and an adjustable compression pad.

Among the group of cases in which sphincteric control is abolished, the operation most frequently performed and the surgical procedure of choice for simple pyloric obstruction and duodenal ulcer is posterior gastro-jejunostomy. In the erect position the prominent feature of this procedure is the immediate passage of the opaque medium into the jejunum. The pyloric antrum, distal to the stoma, rarely fills to any extent, even if the pylorus has not been occluded in a case of duodenal ulcer. The efferent jejunal loop and the coils of jejunum are usually somewhat distended with barium and a mild permanent dilatation of the upper jejunum is normal. In the supine position a pool in the fundus may remain for a time being there below the level of the stoma. If the stomach before operation was grossly dilated and atonic and its muscle coats too atrophied to be restored to the normal, the radiographic picture after gastro-jejunostomy will be somewhat modified. Some dilatation will remain, the indentations of the greater curvature will be less, and there will be a tendency to pool formation in the pyloric antrum below the stoma.

Because of the incomplete filling of the stomach after posterior gastro-jejunostomy the demonstration of recurrent duodenal, pyloric, or lesser curvature ulcers may be impossible because of the rapid emptying of the stomach. The author's pressure apparatus is especially useful in these cases in permitting all portions of the stomach to fill more completely. In cases in which there is no obstruction of the pyloric canal, the duodenal bulb may be likewise visualized.

The complications of posterior gastro-jejunostomy which may be determined radiographically are as follows: (1) jejunal dumping or dumping stoma, (2) recurrent lesser curvature duodenal, gastro-jejunal or jejunal ulcerations, (3) jejunitis, (4) narrowing of the stoma, (5) malposition of the stoma, (6) duodenal ileus.

The x-ray appearances in anterior gastro-jejunostomy are substantially the same as those in the posterior operation except that in the lateral view the stoma and jejunal loop are visible anterior to the stomach and two jejunal limbs afferent and efferent are often outlined below the stomach.

Following Billroth II partial gastrectomy the radiographic examination will be similar to that of the gastro-jejunostomies, except that the pyloric antrum will not be visualized. The Polya Moynihan partial gastrectomy results in a smaller gastric stump than in the Billroth II operation, and the anastomosis will appear to be terminal.

Following complete gastrectomy, radiographic examination shows the meal passing from the esophagus rapidly through the stoma into the coils of the jejunum. Some dilatation of the proximal jejunal loop may be seen as noted by Butler in a case six months after complete gastrectomy.

J. N. ANÉ, M.D.

An Analysis of One Thousand Consecutive Examinations of the Stomach and Duodenum from the Clinical Roentgenologic, and Surgical Viewpoints with Particular Reference to the Incidence, Diagnosis, and Treatment of Gastric and Duodenal Ulcer and Carcinoma of the Stomach. Nelson M. Percy and David S. Beilin. *Am. Jour. Roentgenol. and Rad. Ther.*, August, 1934, 32: 179-188.

The division of vital statistics at Washington reveals for 1931, 4,978 deaths from ulcer of the stomach, 2,281 from ulcer of the duodenum, with respective rates of 4.2 and 1.9. From cancer of the stomach, 25,397, or a rate of 21.3. In the authors' 1,000 consecutive cases there were 21 gastric ulcers, 171 duodenal ulcers, and 71 cancers. Of the gastric ulcers, 4.1 per cent of gastric ulcers occurred in the upper third on the lesser curvature, 20.8 per cent at the middle third, lesser curvature, 12.5 per cent at the lower third on the lesser curvature, and 26.5 per cent at the pylorus. Of the cancers, 8.2 per cent occurred at the upper third, 12.3 per cent at the middle third, and 78 per cent at the lower third. The entire stomach was involved in 1.3 per cent.

All the gastric ulcers had pain 85.7 per cent in the epigastrium and 14.2 per cent diffuse. Nausea occurred in 52.3 per cent, vomiting in 52.3 per cent, hematemesis in 9.5 per cent, gas in 57.1 per cent, relief from food, soda, or drugs in 28.5 per cent, occult blood in 23.8 per cent, weakness in 38 per cent, anemia in 9.5 per cent, and loss of weight in 42.8 per cent. Duration of symptoms varied from twenty years to four months.

In duodenal ulcers, 92.4 per cent of the patients had pain, of which 75.8 per cent had it in the epigastric and 26.9 per cent in the right upper quadrant. Of the painless cases, 70.4 per cent had hemorrhage and bleeding. Nausea was present in 52.6 per cent, vomiting in 56.1 per cent, gas in 70.1 per cent, while 54.3 per cent were relieved by food, soda, or drugs. Occult blood was present in 46.2 per cent, weakness in 42.5 per cent, loss of weight in 48.6 per cent. The duration of symptoms varied from thirty years to one day. Of these cases, 32 per cent had had previous appendectomies and 18 per cent cholecystectomies.

In gastric cancer 59 per cent were examined first over six months after the onset of symptoms. The pain was all epigastric. Nausea, vomiting, hematemesis and gas were greater in the group under 6 months than in those over. For the whole group the longest duration of symptoms was two years, the shortest three weeks.

The earliest symptoms of carcinoma were vague. When gas distress in the epigastrium and nausea are

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X-RAY DIFFRACTION STUDIES ON NERVE

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FROM analysis by means of polarized light it has long been known that nerves possess a high degree of molecular organization. The axis cylinder is positively birefringent due to the presence of anisotropic material, the optic axis of which lies parallel to the long axis of the fiber. The myelin sheath is constructed of lipid fluid crystals with optic axes perpendicular to the direction of the fiber and radially oriented (Schmidt, 18). The positive birefringence of the axis cylinder is due presumably to the protein neurofibrils which, though visible in fixed and stained preparations, have never been demonstrated in living medullated axons under physiological conditions (Peterfi, 16). In view of the success with which the x-ray diffraction method for fine-structure analysis has been applied to certain other fibrous animal tissues such as hair, chitin, connective tissue, etc., it is desirable that full use be made of this tool in the case of nerve, particularly since modern research on nerve energetics reveals that impulse propagation takes place with but extremely small initial energy

liberation. Hill (11) has shown, for example, that the heat production immediately accompanying the propagated disturbance in frog nerve at room temperature is so low as to be near the limit of measurement. It seems obvious that any mechanism capable of propagating an electric potential wave at a velocity of 30 meters per second so efficiently must owe its properties in no small measure to the molecular organization which acts as the physical substratum for the impulse propagation.

Considerable advance has already been made in this direction (Herzog and Janke, 10; Handovsky and Thiessen, 8; Handovsky, 9, and Boehm, 5). Boehm, whose work is the most extensive thus far, obtained the following results. The pattern for fresh nerve consists of a ring with meridional sickles at 4.8 \AA and equatorial points at 17 \AA . The latter points decrease with drying to 11 \AA . By a comparative study of nerves with varying proportions and degrees of development of the myelin sheath, axis cylinder, and connective tissue, he concluded that the 4.8 \AA ring is produced by the radial fluid crystals of the myelin sheath, while the 17 \AA equatorial points are produced by connective tissue. Neurofibrils, according to him, either do not exist or have a side spacing greater than 25 \AA (limit of

¹ We are greatly indebted for excellent assistance in producing the x-ray patterns with greatly improved technique to Dr. J. N. Mrgudich, N. C. Schuetz, and E. A. Parker of the X-ray Laboratories, Department of Chemistry, University of Illinois, and for aid in the making of electrical tests to Mr. Otto Schmitt, of the Physics Department, Washington University.

TUMORS (THERAPY)

The author reviews various aspects of the radiological diagnosis of renal tumors, and discusses the relative merits of retrograde and excretory urography. The last-named method often reveals characteristic distortion of the pelvis and calices in tumors of the kidney and provides a fair estimate of the renal function. Further examination by a retrograde pyelogram, if catheterization of the ureter is possible, may give much added information, and should be employed in all cases in which there is any doubt about the diagnosis.

Pneumopyelography has been described as a simple procedure, which causes little or no discomfort, and is unattended by reactions or danger, but Nichols calls attention to the possibility of resultant fatal air embolism. He concludes, however, that, if the catheter is not tightly gripped in the ureter (as occurs in cases of stricture or ureteral calculus), there is little danger of creating a pressure in the kidney that would be at all hazardous, since the air will flow back into the bladder when the pelvis is filled. Radiograms are made while the air is being injected. The author believes that this method has some very distinct advantages in the diagnosis of pelvic tumors or kidney stones.

Pyeloscopy is also of value, especially after the administration of atropine in cases in which the determination of function has already been achieved or is not necessary; it outlines better the deformity of the kidney caused by a renal tumor.

Nichols emphasizes the importance of giving a guarded prognosis, even though the histopathology of a removed tumor is apparently comforting, and points out that a normal radiogram does not eliminate all possibility of the existence of a newgrowth in the kidney.

Radiation Therapy in Intracranial Tumors. A. Löw-Beer. *Strahlentherapie*, 1935, 52, 617-628.

The present status of roentgen therapy in intracranial tumors is briefly discussed. The author uses single doses of from 50 to 120 r. Irradiation is often preceded by spinal puncture to avoid pressure symptoms following treatment. Technique: 180 K V from 0.5 to 2 mm Cu. During the last four and one-half years eight meningeal tumors have been treated, two of which responded well. The author first applied three fields of 605 r each, then changed to the saturation method, and now administers 2,400 r total dose per field over three areas and repeats this after three months. Twenty-eight glioma cases were irradiated and in 16 there was a definite prolongation of life. Three fields are used, 2,700 r was the total dose per field, repeated after three months. Sometimes severe reactions followed a dose of 300 r in one sitting.

Twelve patients having hypophyseal tumors with the symptoms of acromegaly have been treated during the last five years. In six of these the eye symptoms disappeared completely and three showed temporary improvement. From three to four fields are applied, and from 1,500 to 2,500 r are given per area (fractional dose method).

Highly radioresistant are the tumors originating in Rathke's pouch. Four patients of this type were seen. They were treated through four portals with fractional doses of from 1,500 to 3,500 r total dose per field. In only one case was temporary relief obtained.

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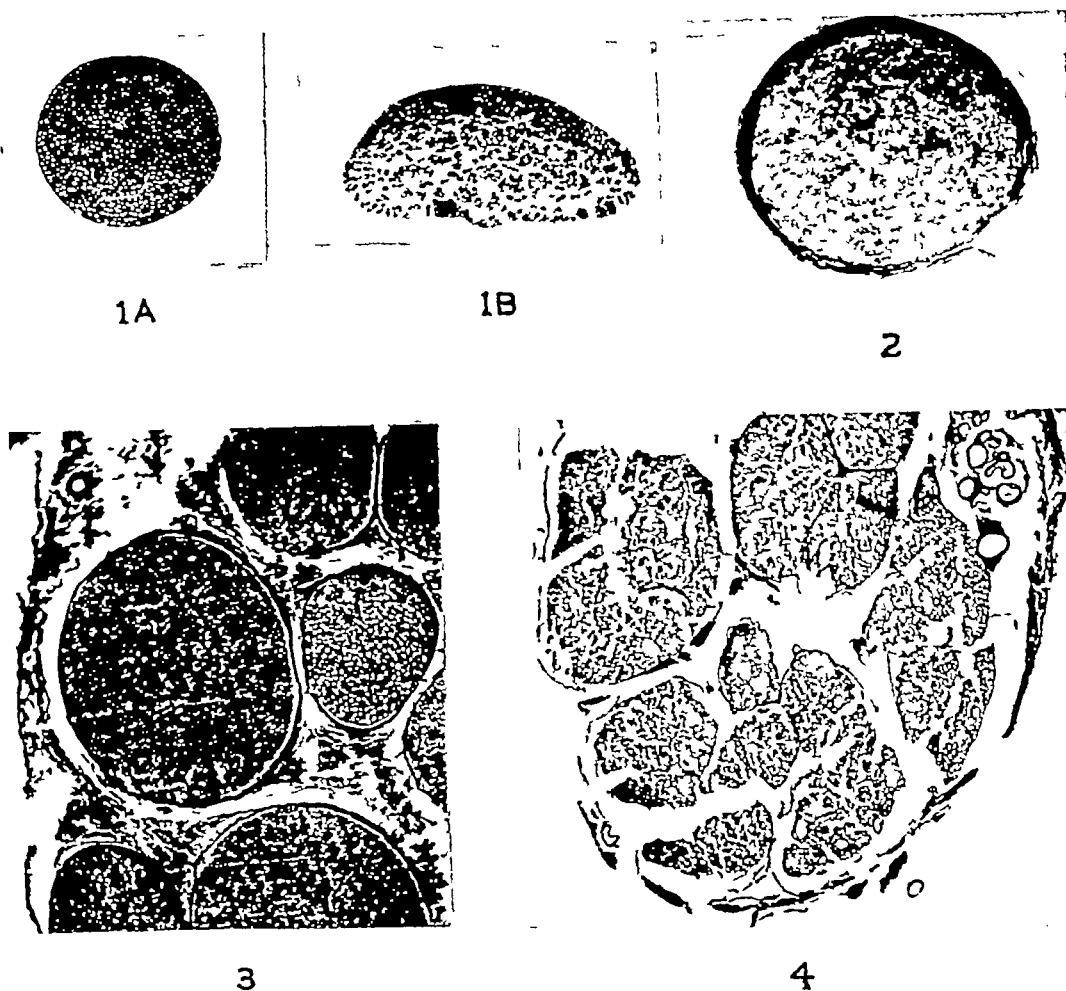


Plate 1 Photomicrographs of nerve tissue prepared as described in text Magnification Figs 1 to 3 48X Fig 4 62X Fig 1 A Bull frog motor root Fig 1-B Cat motor root Fig 2 Branch of bull frog sciatic Fig 3 Cat sciatic Fig 4 Lobster leg nerve

produced no decrease in the action potential, even when the usual exposure time was trebled, indeed, in several instances the action potential was slightly increased by the radiation. Nerves tested in this manner were the sciatic of the frog and motor and sensory roots of the bull frog and cat.

Selection of Material—Boehm's choice of material with which to make a comparative study of the rôle of axis cylinder, myelin sheath, and connective tissue was incomplete. The structures to which physiological interest attaches are the myelin sheath and axis cylinder, and nerve types

should have been selected so that at least one representative type contained these two structures well developed, but no connective tissue. To provide such types we chose the following tissues: corpus callosum, motor roots, sensory roots, sciatic nerve. The corpus callosum may be regarded as the simplest type of medullated material, containing not only no connective tissue, with the exception of glia cells, the chemical nature of which is uncertain, but also no sheaths of Henle or Schwann, moreover, the axis cylinder is not interrupted by nodes of Ranvier. The motor roots of the cat are practically entirely free of

his apparatus), the axis cylinder is a tube filled with a structureless, rather viscous gel

Schmitt and Wade (19, 21, 22) found that nerve shows striking thermal shortening and reacts to solvating and desolvating agents in a manner similar to that of other fibrous tissues such as tendon. These effects were thought to be due, at least partially, to the axis cylinder. In view of the recent work on the significance of thermal shortening and swelling of fibrous tissues (see particularly Meyer, 15, and Kuentzel and Prakke, 13), this indicated a certain degree of orientation in the fresh axis cylinder. We entered upon the present work not only with the hope of obtaining further information regarding the structure of the axis cylinder but also because of the feeling that by improved technique more details of the fine structure of nerve might be acquired by the diffraction method, the number of spacings reported by Boehm and others being disappointingly few.

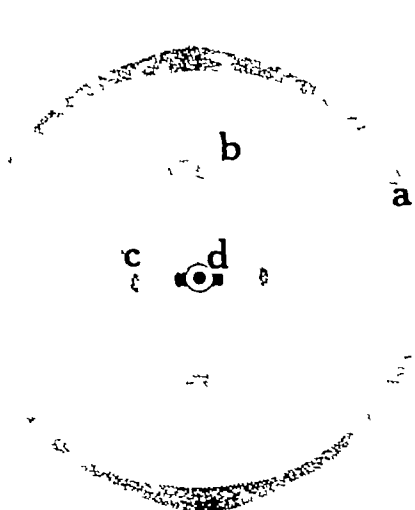
METHODS AND APPARATUS

Since the spacings in nerve are large it is desirable to use large wave lengths. In this work the $K\alpha$ radiation of copper was used as obtained from a Philips Metalix tube operated at 35–40 K V and 20–25 milliamperes. The film was held in a flat holder, the distance from specimen to film varying with the experiment, in most cases the distance was 3 centimeters. The diameter of the pinholes depended also upon the type of experiment being performed. At distances of 3 cm both front and back pinholes were 0.6 mm in diameter. For work on large spacings (specimen-to-film distances up to 20 cm) the pinholes were reduced to a diameter of 0.2 millimeter. The lead beads were always as small as possible and were very carefully centered before each exposure. These precautions with bead and pinhole size are of great importance. Boehm, using 2 mm pinholes, failed to observe the large equatorial points at 40–45 Å and thus was

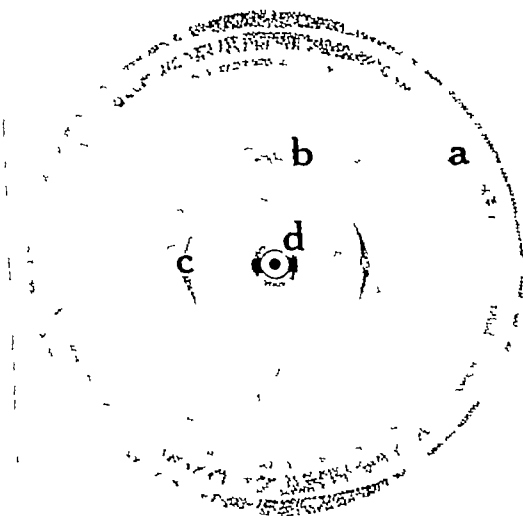
led to an incorrect interpretation of certain features of the remainder of the pattern.

Dried preparations were simply laid over the pinhole and held attached by means of plasticene. For short exposures the patterns of fresh nerves were obtained in a similar manner except that the nerve was kept moist by frequent spraying with Ringer solution from an atomizer. At large specimen-to-film distances when the time of exposure was prolonged the nerve was suspended on a thin glass stirrup and kept in a moist chamber of very small volume to prevent drying. The stirrup was connected to a mechanism by means of which the nerve could be moved in front of the pinhole so as to change the radiated point frequently. The moist chamber was provided with glass windows approximately 5μ in thickness.

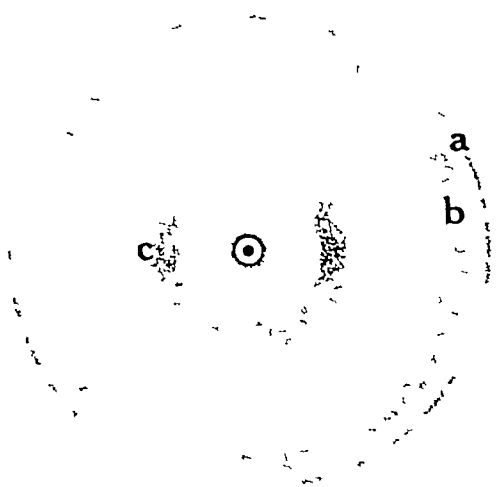
Boehm, as a result of his work on muscle (4), which indicated that the radiation has a decidedly toxic effect, took the precaution of changing the radiated region of the nerve during the exposure. This is obviously an important point, and we determined its significance at the outset of our work. If the radiation produces artificial changes, the patterns resulting may likewise be patterns of the artifacts. To test this point under the worst possible conditions we simply laid a fresh nerve, still connected to its muscle, over the pinhole, keeping the muscle and unexposed portions of the nerve moist with cotton soaked in Ringer solution and moistening the exposed portion of the nerve with an atomizer frequently. Using the threshold method it was found that radiating sufficiently long to obtain a good pattern (10 min), without changing the radiated spot, had no effect whatever on the irritability of the nerve as measured by the threshold method. This method, however, tests the condition of the most irritable fibers only. To obtain information on the condition of the nerve as a whole, action potentials were measured with the cathode-ray oscillograph before and after radiation. The results show that as long as the nerve was not allowed to dry, the radiation



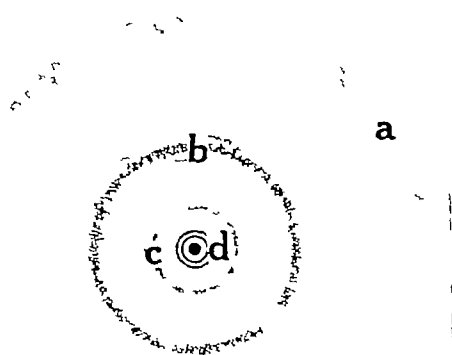
8



9



10



11

Plate 3 Fig 8 Fresh medullated nerve *a* 4.7 Å meridionally sickled rings *b* 9.4 Å meridional spot *c* 15.5 Å equatorial point *d* large-spacing equatorial points Fig 9 Stretched and dried medullated nerve *a* meridionally accentuated rings at 4.20 4.67 5.20 and 5.8 Å, *b* 10 Å meridionally accentuated ring *c* 11.5 Å equatorial point, *d* large-spacing equatorially accentuated rings Fig 10 Lobster or crab claw or leg nerves dehydrated in alcohol under tension *a*, 4.2 Å ring, *b* 4.8 Å ring, *c*, 11.5 Å equatorial sickle Fig 11 Artificial fiber made by spinning nucleoprotein solutions (neutral soluble extract or neurostromin from dried lobster nerves or cow spinal cord) into alcoholic acetic acid *a* 4.8 Å ring *b* 9.1–11.5 Å ring *c* 23 Å ring, *d* 48 Å ring

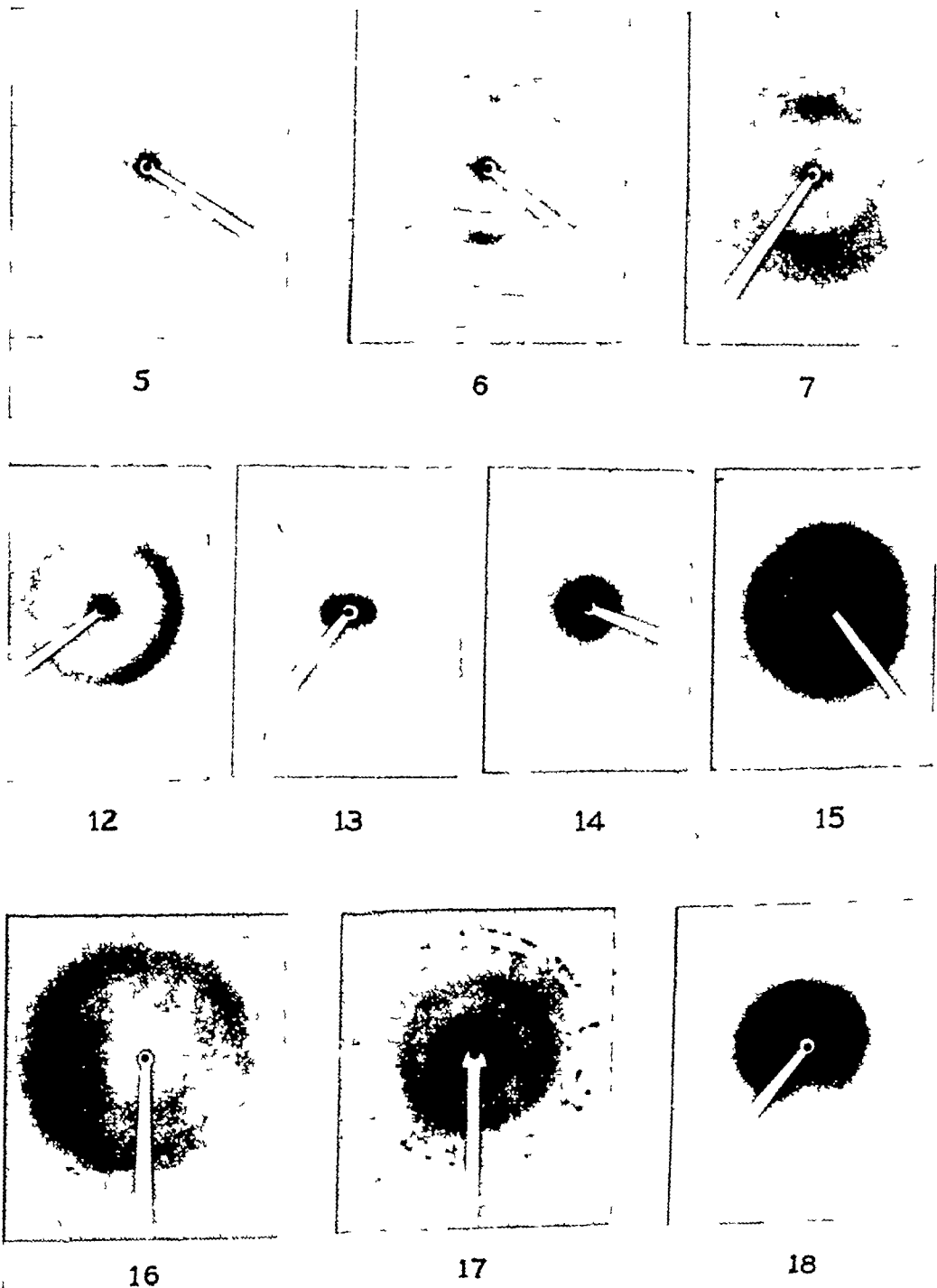


Plate 2 Diffraction patterns of nerves under various conditions Distance from specimen to film (D) = 30 cm All patterns are reproduced without alteration in size Fiber axis is vertical in each case

Fig 5 Fresh frog sciatic Fig 6 Fresh cat motor root Fig 7 Fresh cat corpus callosum Fig 12 Cat corpus callosum dried in desiccator Fig 13 Cat sciatic dehydrated in alcohol under tension Fig 14 Bull frog motor root dehydrated in alcohol under tension Fig 15 Frog sciatic dehydrated by the Scott freezing drying technic Fig 16 Lobster claw nerve fresh Fig 17 Lobster claw nerve dried in desiccator Fig 18 Lobster claw nerve dehydrated in alcohol under tension

points apparently become elongated into sickles, but this spacing is so close to the central spot at 3 cm distance that its behavior with drying must be studied at greater distances. The 4.7 Å ring becomes very considerably broader and there is a tendency toward inhomogeneity (this effect is accentuated in stretched nerves and will be described later).

It is obvious, both from the 4.7 and 40–45 Å spacings, that drying produced considerable disorientation instead of sharpening the picture as might have been expected. It is a well known fact of cytological technique that if dehydration is produced too rapidly, distortion of the orientation of fine fibrils may result. We, therefore, tried a method of very slow dehydration in which the fresh nerves, held stretched out by a 5-gram weight, were transferred to 35 per cent alcohol and thence by very slowly increasing alcohol concentrations eventually into absolute alcohol (the entire process usually lasted about four days). The nerves were then allowed to remain in absolute alcohol for a period of weeks with occasional renewal of the solution. Bull frog motor and sensory roots and green frog sciatics so treated yielded patterns in which equatorial sickles at 11–12 Å were prominent, whereas the 4.7 and 40–45 Å spacings were fainter and entirely unoriented. In cat sciatic and cat vagus nerves, aside from the 11–12 Å sickles, thin, clear, meridional sickles appeared at about 2.7 Å. In Figures 13 and 14 are given typical patterns of alcohol-dried medullated nerves.

We also tried the effect of the liquid air freezing-drying technique³ which is said to dehydrate tissues with a minimum of distortion, but the results indicated as much if not more disorientation than that produced by plain drying in the desiccator (Fig. 15).

2 Non-medullated Nerves—It is interesting to note the changes in the diffraction

pattern which occur as the claw or leg nerves of the lobster are slowly dried in a desiccator. The first change is the fading and disappearance of the inner water ring. With further drying, before the water ring at 3.3 Å disappears, a rather faint ring appears in the neighborhood of 9–11 Å. After complete drying, along with numerous salt rings, a new ring at approximately 4.7 Å appears. This ring, which is quite broad, appeared in several instances to be resolved into separate rings at about 4.2 and 4.8 Å.

Even when stretched and dried, lobster nerve shows little tendency toward fiber-ing. In a few instances the 11.5 Å ring appeared to be intensified at the equator, but the orientation must have been very weak. However, claw nerves slowly dehydrated in alcohol under tension by the process described above showed sharply sickled equatorial spacings between 11 and 13 Å. The ring at 4.7 Å is very much fainter in these nerves than in those dried in a desiccator and faint, thin, meridional sickles appear at 2.8 Å. The large equatorial spacing at 45 Å was not observed in lobster nerves, although in a few instances its presence has been suspected. Figures 16 to 18 show the various types of lobster nerve patterns, while Figure 10 diagrams the alcohol-dried lobster nerve pattern.

Interpretation of Nerve Patterns—These patterns of fresh and dried medullated and non-medullated nerves were previously interpreted as follows (20). In the first place it was pointed out that the 15.5 Å equatorial points of fresh medullated nerves are not due exclusively to connective tissue, as claimed by Boehm. If this were true, then, in our series, fresh sciatics should show the spacing best and spinal roots and corpus callosum not at all. Just the opposite is the case. The clearest and best oriented examples of this spacing were obtained with fresh corpus callosum and spinal roots. The remote possibility that the thin epineural sheath of spinal roots, which does show

³ The frog sciatics and spinal cords were prepared according to this technique by Dr. G. H. Scott to whom we wish to express our appreciation.

connective tissue In the frog there is a thin outer membrane enveloping the roots, and interfibrillary connective tissue is very scanty The Schwann sheath is present and the axis cylinder is interrupted by nodes of Ranvier The sensory roots resemble the motor roots except that there is slightly more interfibrillary connective tissue, the amount being small as compared with peripheral nerve In the sciatic, the connective tissue is said to constitute over half the bulk of the nerve To check the statements found in the literature regarding the structure of these nerves we made a histological examination of the various types under discussion with methods designed to differentiate connective tissue² Immediately after obtaining a diffraction pattern each nerve was plunged into formol-Zenker solution and after embedding in paraffin, sectioned and stained Figures 1 to 3 show the great difference in amount of the connective tissue in spinal roots and sciatics The present series provides an excellent opportunity to study the possible orientation, not only in myelin sheath, axis cylinder, and interfibrillary connective tissue, but also in the Schwann sheath The leg and claw nerves of the lobster and crab were used as examples of non-medullated types (see Fig 4)

EXPERIMENTAL RESULTS

The nerve patterns about to be described were obtained with 0.6 mm pinholes and with the film 3 cm from the specimen Details of the larger spacings obtained at long specimen-to-film distances will be given in a later section

Fresh Nerve

1 *Medullated Nerve*—It is significant that the patterns obtained from each type of medullated nerve were essentially similar Included in the series were cat corpus callosum, motor and sensory roots,

spinal cord, sciatic and vagus, bull frog spinal cord, motor and sensory roots and sciatic, and green frog sciatic Typical patterns are reproduced in Figures 5 to 7

Aside from the water halo at 3.3 \AA , fresh medullated nerve patterns show a ring with meridional sickles at $4.6\text{--}4.8 \text{ \AA}$, together with equatorial points at about 15.5 and $40\text{--}45 \text{ \AA}$ The equatorial spacings tend to elongate into sickles and under certain conditions even into rings They were seen as clear-cut points best in corpus callosum and spinal roots There is usually also a very diffuse ring or halo at from 7.5 to 10.5 \AA While this halo may have several origins it is possible that the proteins of nerve may be responsible for the larger spacing In a number of favorable photographs of corpus callosum and spinal roots it was possible to distinguish a meridional spacing at about 9.4 \AA The location of the various spots and rings are indicated on the idealized diagram, Figure 8

2 *Non-medullated Nerve*—The pattern obtained from fresh leg or claw nerves of the lobster or crab consists merely of two diffuse water halos, one at 3.3 \AA and the other extending between the approximate limits $5\text{--}16 \text{ \AA}$ The latter halo doubtless corresponds to that described by Thibaud and Trillat (26) as resulting from the continuous radiation of the x-ray source when thick scattering materials are employed

Dried Nerve

Drying was usually accomplished by hanging the freshly dissected nerve in a desiccator with a small weight attached to prevent curling

1 *Medullated Nerve*—Perhaps the principal change in the patterns of fresh nerve with drying concerns the 15.5 \AA equatorial points or sickles With simple drying, these points disappear or become extremely faint Coincident with this fading, a new spacing, somewhat equatorially accentuated but appearing usually as a ring, can be seen at approximately 11.5 \AA (Fig 12) The $40\text{--}45 \text{ \AA}$ equatorial

² We are much indebted to Dr James O Leary for advice and assistance with the neurohistological technic.

positive birefringence, or the Schwann sheath may be responsible for the spacing is ruled out by the clearness of the points

drying would indicate intramolecular swelling. Since connective tissue was ruled out as the source of the 15.5 \AA points,

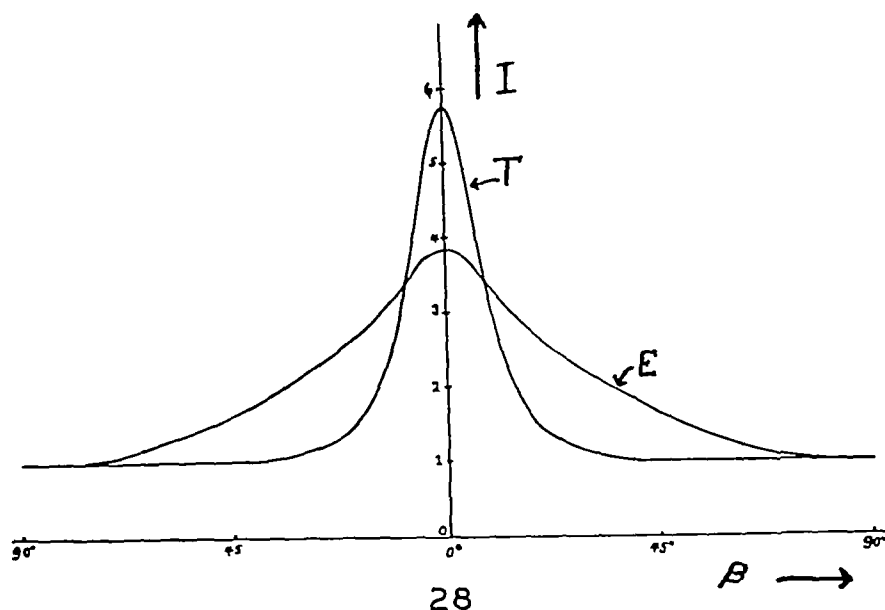


Fig 28 Comparison of theoretical and experimental curves of intensity of the 4.7 \AA ring. I represents intensities relative to that on the equator, β represents the angle of departure from the meridian, T is the theoretical curve. E is the curve obtained from densitometer readings of a typical pattern of fresh medullated nerve. For further details see text.

in corpus callosum, which is devoid of such sheaths.

It is impossible to say that connective tissue in such nerves as the sciatic does not contribute to the spacing at $15\text{--}17 \text{ \AA}$ typical of medullated nerve. That this contribution must be small, however, is indicated by the fact that even fresh muscle, which is rich in connective tissue, yields no such characteristic spacing (Boehm, 4).

The analogy with collagen fibrils, pointed out by Boehm, is striking. In nerves, just as in collagen, drying causes the disappearance of the $15\text{--}17 \text{ \AA}$ spacing and the appearance of a more or less oriented equatorial spacing at $11\text{--}13 \text{ \AA}$. On the assumption that protein fibrils are the cause of both spacings, the decrease with

the tentative view was taken that this spacing is produced by axis cylinder proteins. This view was strengthened by the fact that while, to be sure, no points at 15.5 \AA were obtained in fresh lobster nerve, very clear equatorial points and sickles at $11\text{--}13 \text{ \AA}$ were gotten from lobster and crab nerve slowly dehydrated under tension in alcohol. Crab claw nerve is said by Boehm to be practically 100 per cent axis cylinder material. That the 4.7 \AA ring with meridional sickles may be another protein spacing, presumably representing periodicities along the lengths of much folded chains, was suggested largely because this spacing was found also in dried lobster and crab nerve, the latter, according to Boehm, contains only negligible amounts of lipid.

Figure 23 except that lipoids had been allowed to dry for three hours. $D = 4.44 \text{ cm}$. (25) Fresh bull frog motor root mounted on stirrup in moist chamber. $D = 10.95 \text{ cm}$. (26) Fresh frog sciatic mounted on stirrup in moist chamber. $D = 11.11 \text{ cm}$. (27) Lipoids from benzene extract of dried cow spinal cord. $D = 12.80 \text{ cm}$. (28) Bull frog motor root dried in desiccator. $D = 20.80 \text{ cm}$. (29) Mixture of cholesterol and lecithin rubbed up with water and smeared on stirrup in moist chamber. Further details in text. $D = 11.10 \text{ cm}$. (30) Same as Figure 30 except that stirrup had been removed from moist chamber and lipoids dried for seven hours. $D = 12.30 \text{ cm}$. (31) Same as Figure 30 except that stirrup had been removed from moist chamber and lecithin allowed to dry for seven hours. $D = 11.19 \text{ cm}$. (32) Lecithin rubbed up with water mounted on stirrup and placed in moist chamber. $D = 11.10 \text{ cm}$. (33) Same as Figure 32 except that stirrup had been removed from moist chamber and lecithin allowed to dry for seven hours. $D = 11.19 \text{ cm}$.

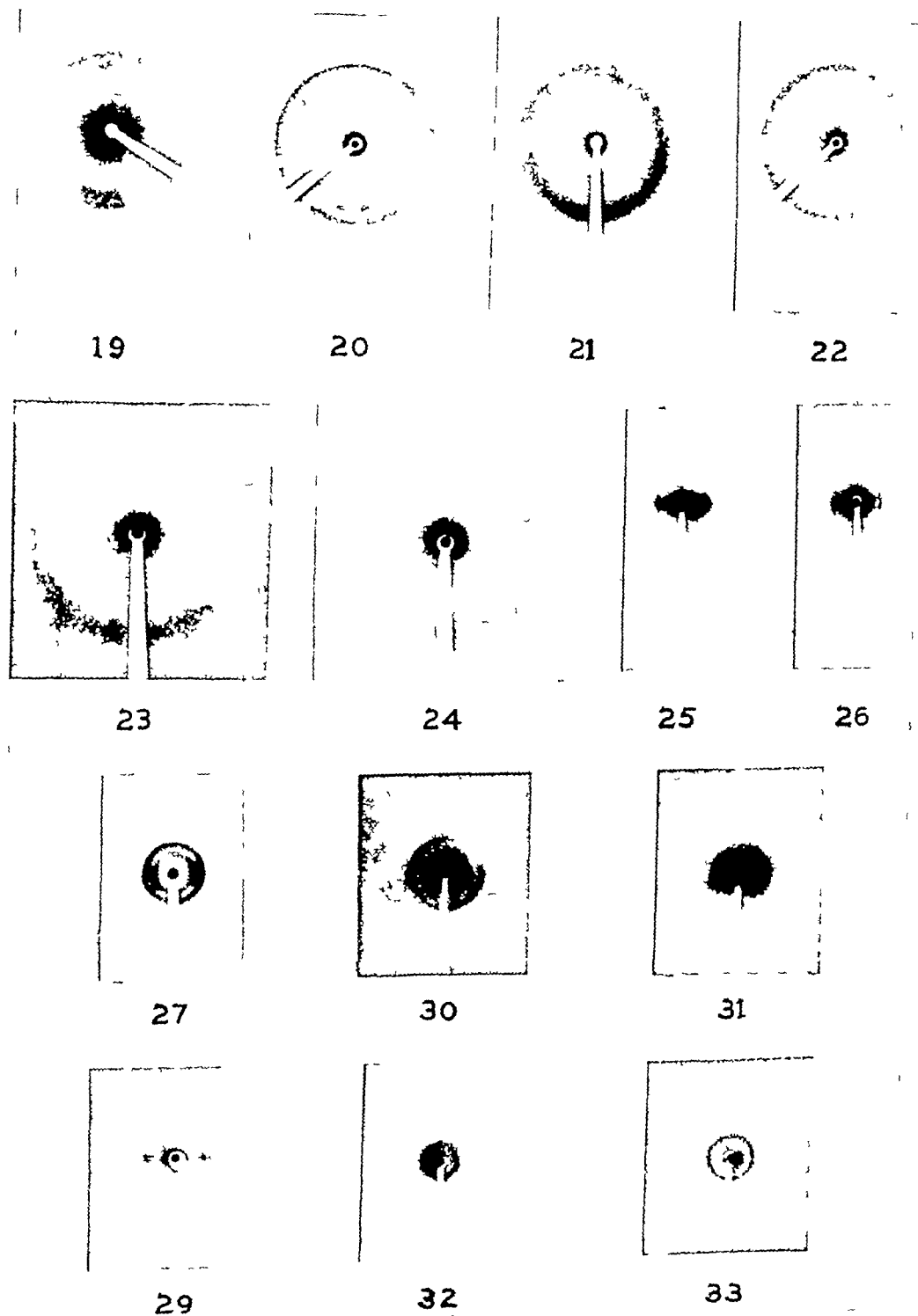


Plate 4

(19) Bull frog motor root stretched 34 per cent while in fresh condition and dried in desiccator while stretched D = 3.0 cm (20) Lipoids from benzene extract of dried cow spinal cord D = 3.0 cm (21) Lecithin D = 3.0 cm (22) Artificial fiber made by spinning a benzene extract of dried cow spinal cord into acetone D = 3.0 cm (23) Benzene extract of dried cow spinal cord rubbed up with water and mounted on loop before pinhole D = 4.4 cm (24) Same as

be seen that the rings, observed in dried and stretched medullated nerves, at 4.20, 4.67, 5.20 and 5.7-5.9 Å appear also in these lipoids, the 4.20 and 4.67 Å² spacings apparently belonging to phosphatid and the 5.20 and 5.8 Å spacings to cholesterol. Furthermore, extraction of the lipoids with acetone results in material for which the 5.2 and 5.8 rings are considerably weaker (Fig. 22). It is not implied that other nerve lipoids may not contribute to the pattern beside lecithin and cholesterol, it is very probable that they might, since the region from 4 to 6 Å might well correspond to a dimension of the unit cell of any of them.

Since individual components of the myelin sheath (phosphatid and cholesterol) can be identified from the series of rings into which the 4.7 Å ring of fresh nerve breaks up upon drying, we next attempted to reproduce the 4.7 Å ring itself from wet lipoids. For this purpose the dried solid obtained by evaporation of the benzene extract of cow spinal cord was rubbed up with water and placed on the stirrup in the moist chamber before the pinhole. The patterns contained rings at 4.6 and 15.7 Å, both being spacings observed in fresh medullated nerve. The wet lipoids were then removed from the moist chamber and allowed to dry for three or four hours and another photograph made for the purpose of comparing the wet and dry pictures from one and the same preparation. The results are shown in Table I and Figures 23 and 24. Of significance in these patterns is the fact that not only do the extracted lipoids reproduce the behavior of drying medullated nerve with respect to the 4.6-4.8 Å ring but also with respect to the 15.5 Å ring. The latter spacing, which is prominent in the pattern of wet lipoids, greatly fades and almost disappears upon drying. Similar results were obtained also with lecithin and with a cholesterol-lecithin mixture.

* The 4.67 Å spacing is undoubtedly complex as pictures taken at large specimen to film distances with nerve lipoids have indicated. However the greater proportion of phospholipids present in nerve would make it seem likely that scattering in this position is in greater part related to the 4.65 lecithin (or phospholipid) spacing.

This discovery of the presence of a spacing at approximately 15.5 Å in lipoids and of the fact that this spacing tends to fade with drying necessitated a radical change in our views of the rôle of axis cylinder proteins in nerve patterns. Up to this time we had assumed, in analogy with the case of collagen, that the 11.5 Å equatorial points of dried nerve corresponded to the 15.5 Å points of fresh nerve, the decrease in spacing being caused by intramolecular desolvation. The possibility now presented itself that there may be no connection between the 15.5 Å and 11.5 Å spacings, since the behavior, in nerve, of the former with drying can be reproduced with lipoids free of protein. Such an eventuality would remove our diffraction evidence for the existence of oriented protein chains in the axis cylinder of fresh nerve, hence the interpretation of this spacing became one of our chief concerns.

If this spacing is due to lipid, it almost certainly must represent a spacing in the *c* direction because of its orientation and because the lipoids in the myelin sheath are known to be incorporated in fluid crystals whose optic axes lie radially. However, Thiessen and Spychalski (27) had shown that lipoids such as the oleates associate end-to-end in pairs giving *c* spacings of the order of 42-45 Å. We had in fact come to regard our 40-45 Å equatorial points as representing such a spacing in the fluid crystals of the myelin sheath, since similar spacings were observed in extracted lipoids and in lecithin smears. The clue which led to the solution of the problem was the fact that several of our 3-cm photographs of fresh motor roots in which the bead happened to be slightly off-center showed the 40-45 Å spacing undoubtedly complex, with an outer difficultly measurable point lying roughly at 35 Å. This suggested the possibility that both the 15.5 and the 35 Å points might be higher orders of a larger fundamental spacing which was indicated in our pictures but which was too close to the primary beam for measurement.

Large Spacing Photographs—To obtain greater detail with respect to the large

It had been found (22) that nerve when treated with certain solvating reagents such as thiocyanate shows a type of supercontracture in certain respects similar to that of keratin. Under these conditions both medullated and non-medullated nerves shorten from 60 to 70 per cent and show perfectly reversible elasticity when stretched to and somewhat beyond the original length. Indeed, even normal untreated nerves may be stretched without rupture as much as from 40 to 50 per cent, although this stretching is not reversible as in the case of supercontracture. On the assumption that the nerve pattern was due largely to oriented protein chains it became desirable to determine whether stretching might produce a new form comparable to the α - β shift found by Astbury for keratin (1) and more recently also for muscle (2). We, therefore, obtained patterns from nerves, particularly spinal roots, which had been stretched and dried while stretched. These photographs revealed no apparent change on the equator which might be interpreted as indicating an α - β shift. They did, however, reveal a very interesting separation of the 4.7 Å ring into a series of rings with meridional accentuation, the principal ones having spacings of approximately 4.2, 4.7, 5.2 and 5.7-5.9 Å (Figs 19 and 9). At this time also, in the course of an investigation on the chemical composition of unmedullated nerve it was found (3) that the lipid content of lobster nerves, far from being negligible in amount, may be as high as 25 per cent of that of the white substance of the brain. This, together with the difficulty of interpreting the separation of the 4.7 Å ring into several rings with stretching and drying, upon the basis of proteins reopened the possibility that this ring may be due to myelin.

Diffraction Patterns from Extracted Nerve Lipids—To obtain more decisive evidence of the origin of the various parts of the nerve pattern, the lipid and protein components were separated by a process of fractionation and the patterns of each constituent studied separately. Lipid

fractions were obtained by extraction of dried cow spinal cord with a mixture of 95 per cent benzol and 5 per cent alcohol. Such extracts were evaporated and the dried solid placed in loops before the pinhole (Fig 20). The protein extraction will be described later.

These photographs (Figs 20 to 22) revealed at once that the 4.7 Å ring is due to the lipoids of the myelin sheath. Indeed, as will be shown, with the exception of the orientation effect,⁴ the lipoids gave patterns which almost completely reproduced those of fresh medullated nerve including the 40-45 Å spacing.

Since dried extracted lipoids gave patterns similar to those of dried medullated nerve, we next attempted to identify individual components responsible for the patterns of each. For this purpose it would have been desirable to obtain patterns from lecithin, cholesterol, cephalin, sphingomyelin, kersin, phrenosin, nervon, and hydroxynervon, as the principal components of the myelin sheath. Of these we have so far tried only lecithin, as an example of the phosphatids, and cholesterol, to which the strong birefringence of the myelin is in great part due (see Göthlin, 7). Boehm believed the 4.8 Å ring in fresh nerve due particularly to mixtures of cephalin and cerebroside. These and other members of the above-named group will be investigated in the near future.

Powder crystal photographs of cholesterol revealed the spacings shown in Table I. Lecithin was obtained according to the method of Levene and Rolf (14). Although the sample used was somewhat darker in appearance than when freshly prepared, the degree of saturation was doubtless low. The material was rubbed into a loop and placed before the pinhole for radiation. The chief spacings found for lecithin are also given in Table I, the pattern and reproduction in Figure 21. It will

⁴ In several of these smear preparations the patterns showed decided orientation due presumably to the momentary stroking necessary in rubbing the material into the loop or stirrup. In such cases the same mutual directions of accentuation of the rings were observed with the lipoids as in nerve patterns.

this question a calculation was made⁶ of the intensity to be expected at any point along the 4.6–4.8 Å ring of fresh nerve on the assumption that the *c* direction (planes parallel to which are considered to be forming the ring) of the myelin sheath crystals is always directed radially and perpendicular to the direction of the fiber, while the *a* and *b* axes are in completely random orientation. Figure 28 shows the calculated curve

⁶ The theoretical curve of Figure 28 was calculated from the relation

$$I = \sqrt{\frac{1 - \cos^2 \beta \cos^2 \frac{\alpha}{2} (2 - \cos^2 \beta)}{1 - \cos^2 \frac{\alpha}{2} \cos^2 \beta}}$$

in which α is the angle of scattering and β is the angle which expresses the departure of the scattering from the meridian. I is an intensity relative to the intensity for $\beta = 90^\circ$. The Bragg requirement $n\lambda = 2d \sin \alpha/2$ determines α for any given d . The calculated curve of Figure 23 is actually for $\alpha = 10^\circ$, and is therefore sufficiently close to that for $d = 4.7$ Å to which the experimental curve refers.

and an experimental curve obtained by measuring the relative intensities of a typical photograph with a densitometer. It will be seen that the maxima and the minima of the curves coincide and that the shapes of the two curves show sufficient agreement to substantiate the fundamental assumption. The departure of the experimental from the calculated curve is simply a measure of the departure from perfect orientation, to be expected in such biological material.

With drying the large-spacing pattern of medullated nerve changes in an interesting manner. Equatorial points are to be distinguished at 140 and 71 Å and a ring with equatorial accentuation appears at 43 Å (Fig. 29). This behavior indicates that drying causes a separation of lipoidal components. In the fresh condition the lipoids appear to be associated in a single type of fluid crystal, presumably of the smectogenic type. With drying this or-

AND IN LIPOID AND PROTEIN EXTRACTS OF NERVES

Wet Lecithin	Dry Lecithin	Cholesterol Powder Diagram (Principal Rings)	Wet Lecithin-cholesterol Mixture	Dry Lecithin-cholesterol Mixture	Nerve Lipoids Spun into Acetone	Nerve Protein Fibers
		3.55 mfR			3.34 fR	
	4.22 Å sR		3.80 Å fR 3.90 fR	3.80 Å fR 3.88 fR	4.18 sR	
4.6 Å sR	4.05 sR	4.97 Å sR 5.28 sR	4.77 mfR 5.02 mfR 5.25 fR 5.47 mfR 5.62 mfR 6.00 sR 6.55 mR	4.75 mfR 4.98 mfR 5.13 fR 5.37 mfR 5.55 mfR 5.91 sR 6.48 mR	4.62 mR 5.18 fR	4.8 mR
	7.2– 10.1' fR	5.95 sR 8.2– 11.0' fR			7.2– 10.3' fR	
18.3 fR		17.5 mR	17.1 fR	17 fR		9.1– 11.5' ssR
31.7 mR		34.8 sR	34.6 sR	34.5 mR	15–16 ² fR	23 mR
63.3 ssR	44–50 ² ssR		68.7 ssR	50 sR	Not Photographed	48 sR
126 mR						

² Figures given show variation in center of intensity.

³ The spacing is probably multiple.

Intensities are indicated very roughly and should be compared with caution between different columns and between widely separated portions of the same column.

spacings, photographs were made with very small pinholes (0.2, 0.2, 0.2 mm), well centered small beads, and with distances of 10–20 cm from specimen to film. The exposure time was considerably greater for these photographs, although very good patterns were obtained from lipoids, for example, in one-hour periods. The results were surprising and highly significant. Fresh bull frog motor root or green frog sciatic showed rings with very clear equatorial accentuation at 85.5, 56.8, 42.7, 34.2, and 15.5 Å (Figs 25 and 26). The first four clearly represent the second, third, fourth, and fifth orders of a unit spacing of 171 Å. On this basis, the 15.5 Å represents the eleventh order. Why the eleventh order should show up when all the intervening orders are either absent or too faint to be measured is not clear, although the intensities are such that the 15.5 spacing might very easily represent such a high order.

The discovery of such large spacings previously unsuspected for nerve or other animal tissues caused us to reinvestigate all of our material with the object of revealing large spacings. The results are included in Table I, which is a composite table without reference to the specimen-to-film distance at which each spacing was obtained.

Considering first the light which these long-distance photographs throw on the structure of medullated nerve, one can say with considerable certainty that the 15.5–16 Å equatorial points and sickles of fresh nerve are produced by the lipid fluid crystals of the myelin sheath. The entire picture, therefore, of fresh medullated nerve, would be due to the myelin sheath. This interpretation requires the assumption that the *c* axes of the myelin sheath fluid crystals are surprisingly well oriented. Is this assumption justified? To answer

TABLE I—COMPOSITE TABLE OF SPACINGS FOUND IN NERVES

Fresh Medullated Nerve	Alcohol-dried Medullated Nerve	Alcohol dried Non-medullated Nerve	Stretched Dried Medullated Nerve	Dried Nerve Lipoids	Wet Nerve Lipoids
	2.73 Å fMS	2.81 Å fMS	2.77 Å fMS	3.36 fR	
4.6–4.8# sMSR	4.2 mMR 4.8* mMR	4.2 mR 4.8* mR	4.20 sMR 4.67* mMR 5.20 mMR	4.17 sR 4.66* mR 5.20 sR	4.6 Å sR
9.4 ffMS	10 ffMR		5.8 fMR 10 fMR	5.8 mR 6.4 fR 7.3–10.4' fR	
15.5 mfES	11.5 mES	(11–13)# mES	11.5 mES	16 fFR 23 fFR 33.3 fR	15.7 mR
34.2 mES 42.7 ssES 56.8 mES 85.5 ssES	See Stretched dried Nerve		43 sER 71 sES 140 ffES	44.5 ssR 67.5 ssR	Too Dense for Measurement

Explanation ff, f, mf, m s ss indicate degrees of increasing intensity from very faint to very strong. M and E indicate meridional (along fiber) and equatorial (transverse) intensifications respectively.

S is employed to indicate strong intensification in a specified direction. R represents a ring.

' Figures given are limits of diffuse rings.

ciate to form this characteristic fluid crystal type or whether only a few of the lipoids are so associated, the remainder being distributed at random or forming a multiplicity of fluid crystal types, none of which is sufficiently often reproduced to give rise to diffraction patterns. If the myelin sheath is made up of concentric layers of these leaflet fluid crystals, each having a thickness of eight molecules, or 171 \AA , there would be something less than two hundred such layers even in the thickest myelin sheath and perhaps only of the order of several dozen in thin sheaths. It is, of course, not impossible that the actual aggregate has a c dimension some multiple of 171 \AA . Our present information merely tells us that 171 \AA is the smallest value, but it is entirely possible that subsequent work either with longer wave lengths, longer distances, or both may reveal this higher organization. We have indeed observed diffraction phenomena with the Spierer lens which indicate a higher organization of the myelin sheath, but the difficulties of interpretation of the results with this method appear insurmountable at present.

That this high degree of organization of the myelin sheath must be of physiological significance is patent. Omitting for the present any discussion of the bearing which this structure may have on the electric resistance, permeability, and polarizability of the myelin sheath, we should like to make only one point of application. It has been found (25) that nerve may be dried to a certain point (loss of over 60 per cent of its water) without irreversible loss of irritability. Further drying makes it impossible to restore irritability by subsequent soaking in Ringer solution. From the above considerations it is not impossible that the limits of reversibility are set by the ability of the crystals, which have segregated upon drying, to reorganize into the original mixed crystal type. This and other physiological consequences of this organization are being investigated.

Non-medullated nerve, fresh or dried, produced no pattern in the large spacing

range. Since we have come to regard the lipoids as responsible for the easily obtainable large spacings, this means that the lipoids of lobster and crab nerve are not sufficiently oriented to produce diffraction. Analysis of lobster nerve (3), however, shows that sufficient lipid is present to produce a pattern if it were oriented. From this it would appear that the chief difference between the lipoids in the axis cylinder and those in the myelin sheath concerns the degree of orientation and organization.

Since the work of Göthlin (7) it has been known that certain forms of non-medullated nerves, the so-called metatropic nerves, to which class lobster nerve belongs, can by treatment with glycerine be made negative in birefringence instead of positive, the normal condition. According to Göthlin, this reversal of birefringence is due to orientation of lipid molecules produced by the transversely directed tension which accompanies glycerine dehydration. The reversal is due to lipoids because the effect cannot be accomplished if the nerve had been extracted with lipid solvents before the glycerine treatment, and because negative birefringence in biological objects is produced as a rule by lipoids. Since preliminary extraction with acetone also prevents the glycerine reversal, Göthlin assumed that cholesterol is the lipid specifically concerned. We have extended these observations and have found that the reversal may be accomplished even after extraction of all nerve proteins except neurostromin (23).

Since the diffraction method serves to reveal lipid orientation we next studied the glycerine reversal by this method. Lobster nerves were soaked for long periods in glycerine and, after preliminary test to prove that the birefringence was negative, the nerves were blotted free of superficial glycerine and radiated. The photographs revealed mutually perpendicular sickles at about 35 \AA and $\pm 13 \text{ \AA}$. These results are difficult to interpret since the 35 \AA is typical of cholesterol while the $\pm 13 \text{ \AA}$ is typical of lecithin. They substantiate Göthlin's view that glycerine causes an orientation of

ganization is disrupted and individual components behave differently, some remaining well oriented (140 \AA —cholesterol-rich fraction⁷), others being disoriented (43 \AA —phosphatids⁷). This separation of lipoidal components is indicated also by the change from an indistinct ring with meridional sickles at $46\text{--}48 \text{ \AA}$ to a series of rings each with meridional sickling, to which reference has already been made. This behavior may be observed also in mixtures of single components. Table I shows the effect in the case of a lecithin-cholesterol mixture. Lecithin and cholesterol were dissolved separately in hot chloroform, mixed, and evaporated to dryness. The dry lipoids were then rubbed up with water and the resulting paste smeared onto the glass stirrup of the moist chamber and placed before the pinhole for radiation. After obtaining a photograph at large specimen-to-film distance the stirrup was removed from the moist chamber and, without disturbing the material, placed in a desiccator. After drying, a large-distance photograph was again made. A similar set of photographs was obtained from lecithin alone. The results are shown in Table I, while Figures 30 to 33 are the patterns obtained.⁷

From these results with wet and dry nerves, extracted nerve lipoids, pure lipoids, and with mixtures of pure lipoids it is obvious that the patterns will depend greatly upon the state of hydration and on the percentage composition of the mixture being radiated. This makes it extremely difficult to reproduce nerve patterns exactly by means of artificial mixtures, particularly as regards the large spacings. It

is also difficult to attempt to identify any single lipoid in nerve by means of a characteristic spacing, since association with other lipoids changes the behavior of the individual components. While these difficulties are realized, certain points appear reasonable, and these will now be discussed, although owing to the limited knowledge of the chemistry of the lipoids the conclusions are to be regarded as tentative.

As has been stated, the lipoids of the myelin sheath appear to be organized as a mixed fluid crystal, presumably smectogenic in type. The dimensions of the unit aggregate may be placed tentatively at from $47 \times 94 \times 171 \text{ \AA}$. The a and b dimensions are reasonable values for the thickness of aggregates containing, in cross-section, four phosphatid molecules arranged in two "puckered" planes. The 171 \AA spacing in the c axis of the aggregate is presumably caused by an end-to-end association of eight lipid molecules which are astonishingly well oriented radially, as brought out in Figure 28 and the discussion above.⁸ It is highly desirable to know whether all the various lipoids of the myelin sheath asso-

⁸ The 47 \AA spacing represents the dimension perpendicular to the planes of the flat sides of the single molecules, while the 94 \AA spacing is that of the width of the pairs of leaflet molecules. Thus, with eight molecular lengths forming the c dimension, the unit aggregate contains 32 molecules in all. It might be argued that the meridional accentuations at 47 and 94 \AA are orders of the same spacing; hence the view presented above must assume a coincidence by which the strong 47 \AA ring is composed of second order reflections from a 94 \AA spacing and first order ones from the 47 \AA dimension. Such a coincidence seems reasonable from the consideration of the unit given above and particularly in view of the observation that lecithin upon drying shows a separation of this ring into two components. Just why this recurrence of structure in the c direction is observed every eight molecules is not clear but one might suppose a repetition with this frequency of a definite order of various types of molecules (including also cholesterol sphingo myelin or cerebroside) or it is possible that unit aggregates or groups of them may be arranged at random in planes much as single molecules are considered to be arranged in smectic fluid crystals. The distance between such plane boundaries would then be 171 \AA . Assuming random orientation of such aggregates about their c axes which are usually radially oriented, the theoretical curve of Figure 28 shows that any dimension perpendicular to the c axis (i.e. both a and b spacings) will be represented by meridional accentuation as is observed.

⁷ The spacings from 38 to 65 \AA for the lecithin-cholesterol mixture (Columns 11 and 12 Table I) are apparently not entirely comparable to those of the nerve lipid pictures probably in large part because of the fact that the mixture employed was rather rich in cholesterol. Thus these spacings are comparable in both dry and wet condition presumably being ascribable to cholesterol-rich liquid crystal combinations of the two substances. Only at large spacings does the separation of lecithin from the cholesterol become apparent, with orders of a 687 (or multiple thereof) c spacing becoming upon drying rings typical of dry lecithin and cholesterol as observed from each in the pure condition.

essary to do preliminary work upon this phase of the problem, particularly because of the lack of information concerning non-medullated nerve, which is representative of axis cylinder material generally. It was found (23, 3) that the soluble proteins of cow spinal cord are similar to those of lobster claw nerve and consist essentially of two nucleoproteins, one soluble in neutral and slightly alkaline solutions and the other (neurostromin) soluble at a pH of about 13, globulins appear to be absent. The possibility of another protein soluble at pH 14 or greater, perhaps collagenous in nature, and present in relatively small amounts has not been ruled out. Spun into an alcoholic solution of acetic acid ($pH \approx 5.0$) from a capillary pipette, both nucleoproteins form threads which show weak positive birefringence. Upon drying, these artificial fibers become strongly positively birefringent and to some extent resemble dried lobster nerves, except for the fact that it has so far been impossible to cause them to swell in water or to show strong thermal shortening.

Radiated at a distance of 3 cm these protein fibers give patterns resembling those of dried lobster nerve. There is a diffuse but fairly intense ring at $9.1-11.5 \text{ \AA}$ and another less intense ring at 4.7 \AA (Figs 34, 35, and 11). Despite the relatively strong positive birefringence, there was little indication of preferred orientation in the diffraction patterns. This is doubtless due to the effect commonly encountered in the spinning of other fibers, namely, that a relatively small superficial portion of the thread becomes well oriented, giving rise to the birefringence, while the inner core of the fiber remains unoriented. All of the artificial fibers gave essentially the same patterns whether spun from the neutral or alkali-soluble extract either of cow spinal cord or lobster nerve.

Because of the similarity of this pattern to that of unoriented fibrin published by Katz and de Rooy (12), we were at first inclined to assume that both rings were due to protein. Subsequent long-distance photographs to reveal large spacings indicated,

however, that this was not the case. Rings at 4.8 \AA and at 2.3 \AA obtained from fibers spun both from neurostromin and neutral-soluble extract showed the presence of lipoid (Fig 36) and it, therefore, appears likely that the 4.7 \AA ring is due also to lipoid. This conclusion is strengthened by the fact that the 4.8 \AA ring, as well as the 4.8 \AA ring, appears fainter in fibers spun into 95 per cent alcohol than in those spun into 40 per cent alcohol. The protein from which the cow spinal cord protein fibers were spun had been extracted several times with benzene and alcohol and the very thin fibers were spun into alcoholic solutions. Yet sufficient lipoid remained to yield a clear-cut diffraction pattern.

These facts make it clear that the proteins are represented in the pattern of lobster nerve by the ring at 11.5 \AA . This ring is diffuse and may lie anywhere between 10 and 14 \AA , depending on the degree of drying, and shows no sign of orientation except in the case of slow alcohol dehydration and tension. Apparently under these conditions the tension and the very slow dehydration combine to preserve the orderly orientation of the protein chains.

The fact that dried motor roots and lobster and crab nerves, as well as sciatics, show equatorial sickles at $11-13 \text{ \AA}$, together with the statement that lobster nerve contains no oriented connective tissue but consists almost entirely of axis cylinder (Boehm, 5), was previously interpreted as evidence that this spacing is due to oriented axis cylinder proteins (20). Recent work, particularly with non-medullated nerves, indicates that this view requires qualification. That the nucleoproteins, which are the principal protein constituents of the axis cylinder, might and almost certainly do contribute to this spacing may be concluded from the fact that when spun into fibers and dried these proteins yield a ring with a spacing of the same order of magnitude ($9-11 \text{ \AA}$). However, connective tissue, if present, would give a similar pattern. Alcohol-dried, stretched lobster and crab nerves also show meridional sickles at 2.8 \AA which might also be

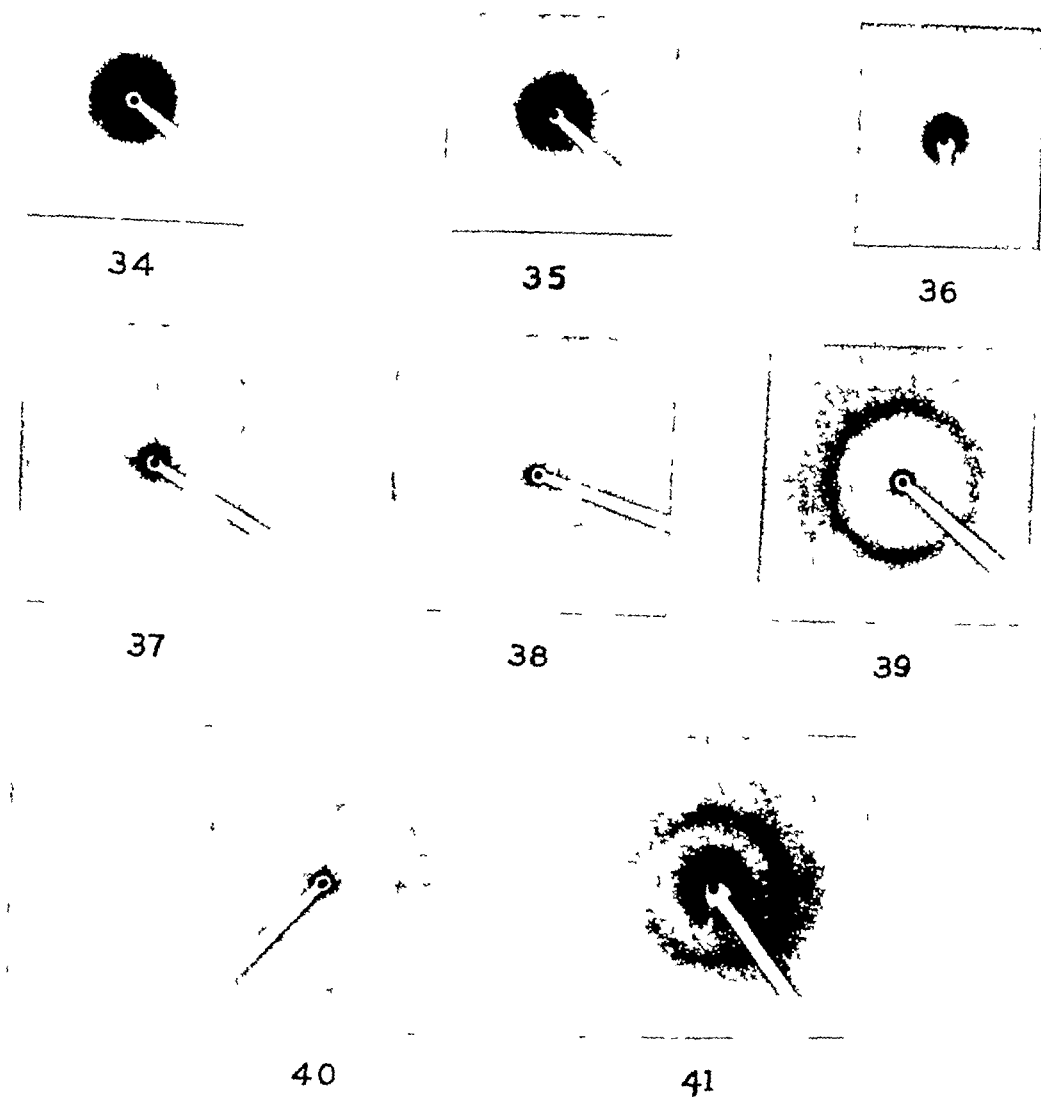


Plate 5 Fig 34 Artificial fiber made by spinning cow spinal cord neurostromin into acetic acid containing 60 per cent alcohol and dried $D = 3.0$ cm Fig 35 Artificial fiber made by spinning neutral soluble nucleoprotein extracted from dried lobster claw nerves into acetic acid containing 40 per cent alcohol and dried $D = 3.0$ cm Fig 36 Same as Figure 35 except that $D = 8.90$ cm Fig 37 Fresh frog sciatic heated to 42°C for 15 min Action potential was unaffected by the heating $D = 3.0$ cm Fig 38 Fresh frog sciatic heated to 44°C for 15 min Action potential was reduced 78 per cent by the heating $D = 3.0$ cm Fig 39 Fresh frog sciatic heated to 46°C for 15 min Action potential extinguished by the heating $D = 3.0$ cm Fig 40 Fresh frog sciatic heated to 70°C for 1 min Shortening = 48 per cent $D = 3.0$ cm Fig 41 Fresh frog sciatic soaked for one hour in 2M NaCNS at 31°C Shortening = 60 per cent. $D = 3.0$ cm

lipoid molecules but indicate that phospholipids, as well as cholesterol, may be involved in the effect

Proteins of Nerve—As pointed out above, while the pattern of fresh nerve appears to be explicable on the basis of lipoids exclusively, that of dried nerve contains spacings

not so far found in lipoids To identify this portion of the pattern was the next problem

The protein chemistry of medullated nerve is at best only poorly understood and that of non-medullated nerve practically uninvestigated It, therefore, became nec-

essary to do preliminary work upon this phase of the problem, particularly because of the lack of information concerning non-medullated nerve, which is representative of axis cylinder material generally. It was found (23, 3) that the soluble proteins of cow spinal cord are similar to those of lobster claw nerve and consist essentially of two nucleoproteins, one soluble in neutral and slightly alkaline solutions and the other (neurostromin) soluble at a pH of about 13, globulins appear to be absent. The possibility of another protein soluble at pH 14 or greater, perhaps collagenous in nature, and present in relatively small amounts has not been ruled out. Spun into an alcoholic solution of acetic acid (pH=ca 5.0) from a capillary pipette, both nucleoproteins form threads which show weak positive birefringence. Upon drying, these artificial fibers become strongly positively birefringent and to some extent resemble dried lobster nerves, except for the fact that it has so far been impossible to cause them to swell in water or to show strong thermal shortening.

Radiated at a distance of 3 cm these protein fibers give patterns resembling those of dried lobster nerve. There is a diffuse but fairly intense ring at 9.1–11.5 Å and another less intense ring at 4.7 Å (Figs 34, 35, and 11). Despite the relatively strong positive birefringence, there was little indication of preferred orientation in the diffraction patterns. This is doubtless due to the effect commonly encountered in the spinning of other fibers, namely, that a relatively small superficial portion of the thread becomes well oriented, giving rise to the birefringence, while the inner core of the fiber remains unoriented. All of the artificial fibers gave essentially the same patterns whether spun from the neutral or alkali-soluble extract either of cow spinal cord or lobster nerve.

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These facts make it clear that the proteins are represented in the pattern of lobster nerve by the ring at 11.5 Å. This ring is diffuse and may lie anywhere between 10 and 14 Å, depending on the degree of drying, and shows no sign of orientation except in the case of slow alcohol dehydration and tension. Apparently under these conditions the tension and the very slow dehydration combine to preserve the orderly orientation of the protein chains.

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expected of connective tissue. Moreover, among the medullated nerves, those with large amounts of connective tissue (cat and bull frog sciatics) show the equatorial sickles best—indeed, plain drying in a desiccator suffices in these cases—while motor roots show the points faintest. The question as to whether these sickles are produced by axis-cylinder proteins or whether connective tissue also contributes hinges to a certain extent upon the relative quantity of connective tissue in non-medullated nerve. Boehm gives no details of the planimetric method by means of which he arrived at the conclusion that crab claw nerves contain “ca 0 per cent connective tissue and 0 per cent oriented connective tissue.” We had always accepted this view because of the ease with which these nerves break apart into numerous strands in sea water. However, since we found his estimate of the lipid content of these nerves to be inaccurate, we made an independent investigation of the histology of the leg and claw nerves of the lobster and crab. The nerves were fixed, sectioned, and stained as in the case of medullated nerves, with methods designed to differentiate connective tissue. It was found that, far from containing a negligible amount, these nerves probably stand somewhere between cat motor roots and cat sciatics in the relative abundance of connective tissue (Fig 4). While there is no outer sheath comparable to the epineurium, each fascicle is surrounded by connective tissue and there is a thin layer of interfibrillary connective tissue between the individual fibers. Moreover, the outer sheath of each fiber stains like typical connective tissue. de Reny (17), in describing single fibers of the lobster ventral nerve chain, states that the sheath is composed of a layer of easily removable fibers (connective tissue?) and an inner smoother layer containing nuclei (Schwann sheath?). We have corroborated these statements not only for the fibers of the ventral nerve chain but also for typical fibers of the claw and leg of lobster and crab. The outer connective tissue sheath is also

positively birefringent and shows marked thermal shortening.

In view of these observations on the tissue which has been serving as a representative of pure axis cylinder, the diffraction evidence of oriented protein chains in the axis cylinder must be considered inconclusive. Even if it were possible to show that interfibrillary connective tissue when stretched and dried does not produce typical equatorial sickles at 11–13 Å, it would still be necessary to show that the fibrous sheath around each fiber also gives negative results. There can be little doubt but that the ring at 10–12 Å in dried non-medullated nerve is produced principally by the nucleoproteins of the axis cylinder, but it has so far been impossible to bring crucial diffraction evidence for the orientation of these proteins.

Thermal Shortening—Patterns were obtained from maximally shortened frog sciatics, motor and sensory roots, cat sensory roots, and lobster claw nerve. All pictures were made at a distance of 3 centimeters. For shortening of 50 per cent the usual effect is simply a decrease in the orientation of the entire patterns. The 15.5 Å points become elongated into sickles or into a ring and the meridional accentuation of the 4.7 Å ring is decreased. This effect is due in part to the irregular folding of the myelin sheath shown to result from thermal shortening by Schmitt and Wade (21). When shortened nerves are examined with polarized light, the contorted myelin sheath shows regions of negative birefringence alternating with regions of positivity depending on the orientation of each portion of the sheath.

There is some indication that thermal disorientation of the lipoids may precede the major shortening process. This was brought out in an experiment planned to determine whether thermal inactivation of the irritable mechanism involves disorientation of the myelin sheath fluid crystals. Frog sciatics were placed in Ringer solution at 42, 44, and 46° C for fifteen minutes. At the end of this period they were returned to Ringer solution at room tempera-

ture and their action potentials determined with the cathode-ray oscillograph. The action potential of the nerve subjected to 42° was the same as that before heating, that at 44° was reduced 78 per cent, and that at 46° was completely extinguished. Although the lengths were not measured accurately, no visible shortening was observed in any of the nerves. The diffraction pattern of the nerve at 42° was typical of sciatics at room temperature (Fig. 37). The 15.5 \AA equatorial spacing was represented by slightly elongated points and the 4.7 \AA ring showed marked meridional accentuation. The large spacing close to the bead also showed strong orientation. The pattern of the nerve kept at 44° showed a decided decrease in orientation (Fig. 38). The 15.5 \AA points were elongated into definite sickles and the 4.7 \AA ring showed only slight meridional accentuation. The nerve kept at 46° gave a pattern practically identical with that of nerves which had undergone maximal shortening by heating to 70° . The 15.5 \AA spacing is represented by a ring or by thin elongated segments of a ring and the large spacing appears to be equally disoriented, no meridional accentuation is visible in the 4.7 \AA ring (Figs. 39 and 40).

Aside from concluding from this evidence that lower temperatures are required to disorient the fluid crystals of the myelin sheath than to cause shortening of the protein structures, it is tempting to infer that the cause of thermal loss of irritability is the disorientation of the lipoids. It has been found that the action potential of frog sciatics declines abruptly at $43\text{--}44^{\circ} \text{C}$ and becomes zero at $45\text{--}46^{\circ} \text{C}$ (24). That the orientation of the lipoids is not the sole cause of this failure, however, is shown by the fact that there is a similar abrupt decline in respiration and in dehydrogenase activity at approximately similar temperatures (19, 24).

The Effect of Reagents and Conditions on Nerve Patterns—Sodium thiocyanate and dilute acid cause great swelling—shortening of medullated and non-medullated nerves (12). As is to be expected, this type of

shortening, as well as thermal shortening, causes great buckling of the myelin sheath and a consequent disorientation of the diffraction patterns. Figure 41 shows a pattern of a frog sciatic which had shortened 60 per cent in 2M NaCNS. Similar patterns were obtained from motor and sensory roots both in thiocyanate and in M/100 HCl. There is a tendency for the spacing in these patterns to be somewhat larger than in those of fresh nerves, averaging 16.5 \AA instead of 15.5 \AA . The reason for this is not clear.

Calcium excess is said to favor the precipitation out of neurofibrils in the axis cylinder of teased medullated nerves (6). To test this effect we soaked a nerve in isotonic calcium chloride solution. The pattern obtained from this nerve after one hour of soaking departed little from the normal. After twelve hours of soaking the pattern showed disorientation which might have been expected from such abnormal treatment.

In an attempt to bring out the protein structure of the axis cylinder we prepared frog sciatics in cytological fixatives known to preserve neurofibrils. Formol-Zenker solution and isotonic potassium dichromate were tried. Some of these nerves were dehydrated by running through the alcohols and others were radiated without dehydration. The patterns revealed no new structures but on the contrary were indistinct and considerably disoriented. This disorientation has been observed in every case in which formalin was used as a preservative.

It is known that impregnation of lipoids with osmic acid abolishes their birefringence (18). We, therefore, treated nerves with osmic acid until quite black and studied the diffraction pattern with the remote hope that if the pattern of the lipoids is destroyed a typical protein pattern might become more apparent. The resulting pattern showed little of the 4.7 \AA ring and nothing of the 15.5 \AA spacing, but there was considerable general scattering about the primary beam indicating

the presence of large lipoidal aggregates probably in random orientation

Because of the marked effect of polarizing currents, both upon the irritability of nerve and upon structure, we arranged to pass current through a frog sciatic during the radiation. At 22.5 volts a current of 2.5 milliamperes was passed continuously during the radiation period which lasted fifteen minutes. The pattern so obtained was one of the clearest and best oriented ever gotten from fresh sciatics. The equatorial points had a spacing of 17.5 Å instead of the usual 15.5 Å and the meridional intensification at 9.5–10 Å was more apparent than in the average pattern of frog sciatics. The significance of these effects is not clear at present.

The Effect of Asphyxial Block on Nerve Patterns—Frog sciatics still attached to the gastrocnemius muscles were placed in M/500 NaCN in buffered Ringer solution until the nerve became non-irritable. Patterns obtained from nerves radiated in this condition appeared to be similar to the normal pattern, indicating that the primary course of asphyxial block is not a disorientation of the lipoids of the myelin sheath. The work of Boehm (5) and of Handovsky (9) indicates that lipid soluble narcotics can disorient the lipoids reversibly. It appears from the work of the latter that chloroform narcosis causes the 4.7 Å spacing to break up into several rings. It is conceivable that these rings are comparable to the rings described above, which appear as a result of stretching and drying and which are caused by a separation out of components of the fluid crystals of the myelin sheath. Since Handovsky does not state the spacings of these rings, it is impossible to determine this point. Further investigation along this line is highly desirable.

SUMMARY

1 The diffraction patterns of fresh and dried medullated and non-medullated nerves are described. Medullated nerves are represented by the sciatic, motor, and

sensory roots of the frog and cat and by the corpus callosum of the cat, non-medullated nerves by the claw and leg nerves of the lobster and crab.

2 The pattern of fresh medullated nerve is probably due entirely to oriented fluid crystals of the myelin sheath, for it can be reproduced fairly completely in preparations made by rubbing up a benzene extract of spinal cord with water. The fundamental aggregate of these fluid crystals appears to have dimensions of $4.7 \times 9.4 \times 17.1$ Å, the various lipoids being associated in a mixed crystal fashion. The c spacing lies radial and perpendicular to the long direction of the axon. This means that in thinly myelinated fibers the myelin sheath is composed of but relatively few layers of these oriented lipoids associated end to end.

3 With the exception of the equatorial sickles at 11.5 Å, the patterns of dried medullated nerve can be reproduced by dried extracted lipoids. Rings with spacings characteristic of phosphatids and of cholesterol can be identified in the pattern of dried nerve. Drying disorients certain of the components of the myelin, leaving others fairly well oriented.

4 Heating frog sciatics causes a disorientation of the lipoids which appears to occur at or about the same temperature at which the action potential is extinguished. Higher temperatures, which cause maximal shortening, have little further effect on the x-ray patterns.

5 Patterns of frog sciatics treated with cyanide until the action potential was blocked departed little from the normal.

6 To study the structure of the axis cylinder, lobster and crab leg and claw nerves were used. These nerves have in the past been assumed to represent pure axis cylinder, containing little or no connective tissue or lipoids. This assumption has been shown to be incorrect by chemical analysis and by histological investigation. The lipid content may be as high as from 25 to 30 per cent of that of the white matter of mammalian brain. Connective tissue is by no means negligible, there is inter-

fibrillary connective tissue as well as fibrous material closely adherent to each fiber. There is also a sheath which appears to be comparable to the Schwann sheath. These facts greatly complicate the analysis of the axis cylinder since the proteins of the axis cylinder give spacings similar to those of collagen of the connective tissue.

7 Artificial fibers spun from the nucleoproteins of lobster nerves, though fairly strongly positively birefringent, indicate no orientation in their diffraction patterns. A ring at 9.1–11.5 Å represents the proteins. Even though these fibers were spun from fat-extracted protein, rings at 4.8, 2.3, and 4.8 Å represent the lipid components.

8 Alcohol-dried lobster nerves show equatorial sickles at approximately the same spacing as that given by the nucleoprotein of the axis cylinder. This fact was originally interpreted as showing that the axis cylinder contains oriented protein micelles. This conclusion must be qualified in view of the demonstrated presence in these nerves of collagenous material which might be responsible for at least a part of the orientation.

9 Although lipids are present in very appreciable quantities in lobster nerve, they give rise to no pattern in fresh nerve. However, if the nerve be treated with glycerine, which changes the birefringence from positive to negative, patterns may be obtained which demonstrate that the lipids have become oriented. Preliminary

experiments indicate that cholesterol and perhaps also the phosphatids are involved in the effect.

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SQUAMOUS-CELL CARCINOMA OF THE KIDNEY

REPORT OF FOUR CASES

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SINCE only 57 cases of epidermoid carcinoma of the kidney have been reported in the literature, and since a correct diagnosis has never been made prior to operation or necropsy, the following four cases are reported

Case 1 The patient, a woman 41 years of age, was seen first on Aug 10, 1924. She complained that for one month she had

mass in the region of the right kidney, and roentgen examination confirmed the diagnosis of kidney tumor, but no calculi were seen on the left side

Examination of the blood revealed 3,000,000 red cells, 22,000 white cells, and the hemoglobin was 60 per cent

Cystoscopic examination revealed a nodular, cauliflower tumor about the size of a



Fig 1 Invasion of the kidney cortex by carcinoma extending from the kidney pelvis

had chills, fever, profuse sweats, and occasional hematuria. Four years before, three stones had been removed from the left kidney, and one year previously a mass had been discovered in the right side which had rapidly grown larger and had become increasingly tender. At the beginning of the onset of the most recent symptoms, two small calculi had been passed which apparently came from the right side.

Physical examination revealed a large

small walnut in which there were areas of engorgement and necrosis, this tumor was in the region of the right ureter. The ureteral orifice could not be identified, and no urine was seen to come from this kidney. No abnormalities of the left kidney or ureter were discovered. From this examination, the clinical impression was that the patient was suffering either from a tumor which involved the lower end of the right ureter with a resulting hydronephro-

sis of the right kidney, or from a papillary carcinoma of the kidney with metastasis to the ureter

ture rose, and the patient's condition gradually became worse until death occurred 28 days after the operation



Fig 2 Large renal calculi. The presence of malignancy was not determined and a diagnosis of calculous pyonephrosis was made

Due to the marked secondary anemia, a blood transfusion was given seven days after the patient was admitted to the hospital, and on the following day an exploration of the right kidney was made. A very large, adherent mass with a very thick capsule was discovered which contained thick, amber, syrupy fluid. Continuous drainage was established and, following operation, the patient's temperature returned to normal for six days. However, at the end of this time, chills, fever, and sweats occurred, the tempera-

Necropsy revealed the right kidney to be markedly enlarged. It measured $9 \times 5 \times 5$ cm, was partly firm, rather yellow in color, and contained abundant perirenal fat which was invaded by nodules. The pelvis of the kidney was dilated and filled with necrotic or degenerated material. A section presented a lobulated, yellowish red, moderately firm appearance, with marked degeneration and hemorrhage toward the central portion. The capsule was thickened, was stripped from the tumor with difficulty, and showed portions of

tumor growth which had eroded through the cortex. Marked thickening and involvement with the tumor growth was apparent. Nocturia, and blood in the urine, present for 10 weeks. Blood first appeared in the urine after a sudden pain in the kidney.



Fig 3 Photograph of wax model of specimen

parent around the ureter and vessels at the hilus.

Microscopic examination of several sections through different portions of the kidney revealed similar pictures, although marked degenerative changes were present in some portions. Of outstanding interest was the finding of large masses and columns of large, atypical, deeply chromatic, stratified, squamous epithelial cells, which grew in wild profusion in every direction and infiltrated deeply. Practically no renal structure was apparent in any area. Pearl formations, degeneration, and metaplastic cells, which probably were due to the degenerative changes, were seen in great abundance.

The pathologic diagnosis was squamous-cell cancer, probably arising from the renal pelvis.

Case 2 The patient, a man 52 years of age, was seen first on April 14, 1933. His chief complaint was of pain in the back,

Physical examination revealed no abdominal abnormalities except muscular spasm over the right lumbar region and tenderness to percussion in the same area. A slight lordosis was present.

Roentgen examination of the kidneys, ureters, and bladder showed no evidence of stones or of other pathologic change in the urinary tract. A pyelogram showed the left kidney to be normal except for a little rotation on the long axis. The lower calyx of the right kidney was seen to be normal, but there was marked compression and infiltration in the upper three-quarters of the kidney (Fig 1). A diagnosis of carcinoma of the right kidney was made. Examination of the urine showed it to be loaded with red blood cells, and considerable albumin was present.

X-ray therapy was advised for this patient, he received six treatments which totaled about two thousand units. Three days after the last radiation treatment,

a right nephrectomy was performed. Pathologic examination revealed a tumor measuring about 7.5×6 cm, which was ent, and the impression was that the growth was a liposarcoma of the right kidney. However, microscopic section of

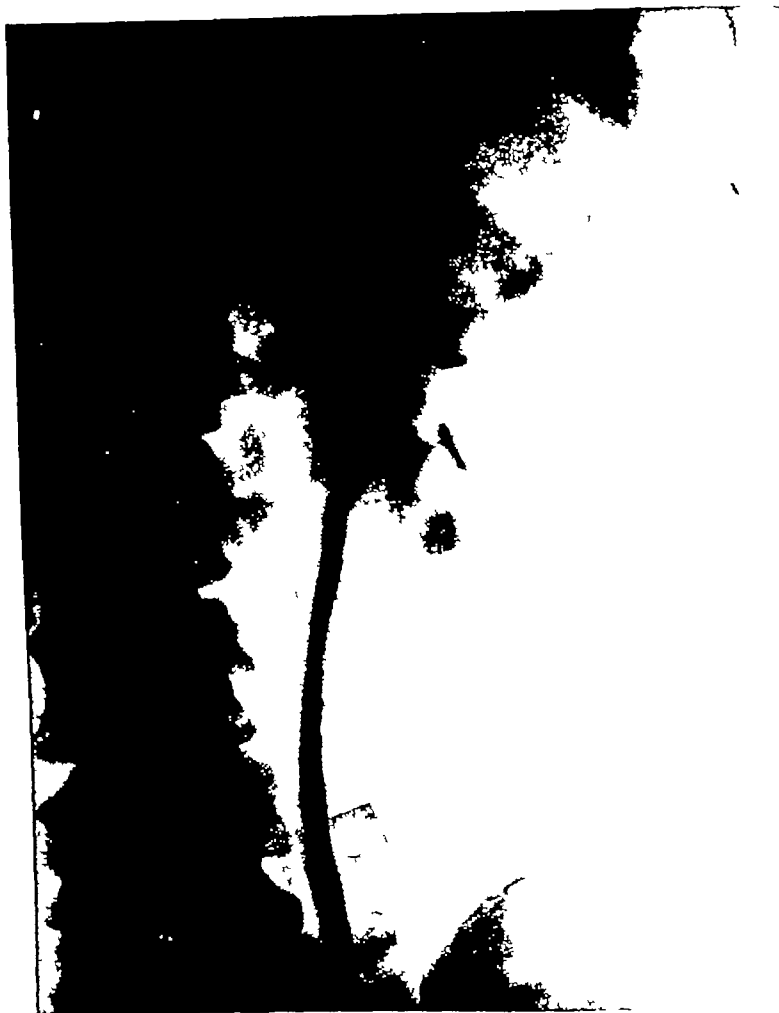


Fig 4 Some obliteration of the caudal calyx. The question of the presence of tuberculosis was considered

fairly well differentiated from the surrounding tissue, and was of a yellowish color. There were a few cortical cysts on the upper pole of the kidney. A section through the firm, rather friable tumor showed it to have a yellowish-gray, rather moth-eaten appearance. It was not well circumscribed, but rather diffusely infiltrated. The pelvis and calices were somewhat compressed by the tumor, but they were patent and contained no stones. The pelvic mucosa showed no gross ulceration, but the upper portion had a slightly roughened appearance. The ureters were pat-

this tumor showed complete loss of the mucosa in some areas, metaplastic changes in the epithelium in still other areas, ulceration of the mucosa, and replacement by infiltrating squamous-cell carcinoma. The cells were of a large squamous type with some tendency to form keratohyalin material, but with no pearl-formation. The tumor had infiltrated diffusely outward from the renal pelvis. In one section, the renal artery was infiltrated and the lumen was occluded by tumor cells. Also, a large branch of the renal vein was invaded

in a similar manner. There were numerous rather large areas of necrosis.

The patient remained well for three months and then returned complaining of pain in the left chest. Examination at this time showed metastatic nodules in both lungs. The patient died from metastases five months after operation.

Case 3 The patient was a man 51 years of age, whose chief complaint was of attacks of pain which had occurred at intervals during the past three years. Between the attacks, a dull ache was present which was referred to the abdomen and back. However, there had been periods of several weeks during which he had been without pain. During these three years, blood had been present in the urine at intervals, and there had been some nocturia. One year before this examination, the patient had had a fall and at that time a diagnosis of misplaced kidney was made.

Physical examination revealed a large, palpable right kidney which was somewhat tender and partially movable.

Roentgen examination of the kidneys, ureter, and bladder showed huge calcific deposits in the right kidney (Fig 2). This kidney was very large, and the diagnosis of calculous pyelonephrosis was made. Examination of the urine showed many blood cells, and a large amount of albumin.

Nine days after admission, a right nephrectomy was performed. Gross examination of the specimen showed nephrolithiasis of the right kidney, hydronephrosis, chronic pyelitis, leukoplakia, and epidermoid carcinoma of the pelvis (Fig 3). Microscopic section of this kidney showed a chronic inflammation of the cortex of the medulla, with ulceration of the mucosa and diffuse chronic inflammatory infiltration. In several of these sections, small areas and solid masses of rather large epithelial cells were present in the subepithelial layers of the mucosa. In some areas, there was complete replacement of the epithelium by keratinization and stratified squamous epithelium. There was no pearl-formation. In some of the sections, the entire pelvic wall was infiltrated to the peripelvic fat.

After operation, chest complications, thrombosis of the pelvic vessels and of the vessels involving the entire right leg occurred. The patient died one month after operation, and postmortem examination revealed metastatic carcinoma of the perirenal fat, right and left peri-aortic lymph nodes of the breasts and lungs, thrombosis of the pelvic veins, thrombosis of the pulmonary arteries, and multiple infarcts in the lungs.

Case 4 The patient, a woman 49 years of age, was seen first on June 15, 1932. Her chief complaint was of pain in the right side. Two years before this examination, she had had a severe attack of pain which lasted for a few hours. Two weeks later, a similar attack occurred, after which the patient was free from symptoms until five months before this examination. The pains began in the right side of the back, radiated around to the groin and to the upper thigh, and were of such severity that morphine was required to relieve them. For the five months previous to examination, the patient had had some constant pain. After the last attack, a large amount of blood was passed, and since that time hematuria had been present for a period of two or three days of each week.

Physical examination revealed no abnormalities. A plain plate of the kidneys, ureters, and bladder revealed no abnormality. A pyelogram showed a filling defect in the lower calyx of the right kidney which it was felt might be due to incomplete filling, a blood clot, or tuberculosis (Fig 4). Examination of the urine failed to reveal the presence of acid-fast bacilli. However, blood and albumin were present in the urine. The clinical diagnosis was stone in the right kidney. The patient was advised to await any further development of symptoms. She returned again in June, 1933, eleven months after the first examination, and reported that hematuria had been present at intervals. A pyelogram made at that time showed a filling defect in the pelvis of the left kidney, and narrowing of the uretero-pelvic

junction, which suggested the presence of a neoplasm

Nephrectomy was advised and the left

One year later the patient had no symptoms of recurrence or metastases of the tumor



Fig 5 Roentgenogram made 11 months after Figure 4 Complete obliteration of the caudal calyx is seen and a diagnosis of carcinoma of the kidney pelvis was made

kidney was removed The specimen showed a papillary type of tumor The lower section of the kidney was filled by a very hard, opaque, yellowish-white growth which was fairly well circumscribed and measured approximately 2 centimeters A papillary tumor arose from the pelvis in the region of the lowermost calyx The pelvic mucosa for the most part appeared thickened and edematous The ureter was apparently normal The diagnosis based on the gross examination was papillary carcinoma of the kidney Microscopic section of the tumor near the uretero-pelvic junction showed a somewhat papillary growth of pelvic epithelium, with invasion of the underlying submucosal and peripelvic tissue by small and large solid masses of squamous epithelial cells The tumor cells varied greatly and showed very little keratinization Mitotic figures were scarce The growth was diffuse, infiltrated the medulla of the kidney, and extended into the cortex

COMMENT

Gilbert and MacMillan (1), in a very thorough discussion of the subject, reviewed all cases of squamous-cell carcinoma of the kidney pelvis reported in the literature, and they were able to collect 55 cases and added two cases of their own

The four cases presented here demonstrate the difficulties encountered in making a correct diagnosis of epidermoid carcinoma of the kidney pelvis

The average age of these patients was 48 years There were two women and two men Hematuria was present in all four cases Stones in the kidney were present in two cases, and pyonephrosis was seen in two cases In two cases a palpable mass was present Three patients gave a history of pain and one of injury

There were no clinical findings in these cases which in any way might be considered to be characteristic of epidermoid carcinoma All cases were subjected to

roentgen-ray examination In the first case, a definite diagnosis of kidney tumor was made from the appearance of the kidney as observed on the stereoscopic roentgenogram of the urinary tract This was in fact the only definite evidence of kidney tumor, and it established the fact that the palpable mass was connected with the kidney In the second case, again the presence of a kidney tumor was determined by the pyelographic film which showed a tumor of the pelvis of the kidney with invasion of the cortex This was interpreted properly as a carcinoma of the kidney

In the third case, the roentgen examination was of no value in determining the presence of a carcinoma of the kidney because of the huge calculi in this kidney and a diagnosis of calculous pyonephrosis was made Pyelographic findings led us to believe that tuberculosis of the kidney pelvis was present in the fourth case, however, 11 months later another pyelogram definitely established the diagnosis of carcinoma of the kidney In none of these cases was epidermoid carcinoma of the kidney pelvis suspected, and only after microscopic study of the tumor was such a diagnosis made

Case 3 well illustrates the presence of squamous-cell cancer of the kidney in the presence of large calculi of the kidney associated with inflammation and leukoplakia, and in the presence of such findings, one should suspect the possibility of such a tumor at the time of the examination In this case there was a history of injury which may be of significance as an etiologic factor However, the large multiple calculi may be considered as the most logical

contributing factor because of irritation and the production of leukoplakia It is interesting to note that Nicholson (2) reported 16 cases of squamous-cell carcinoma of the gall bladder in 15 of which gallstones were present This tends to confirm the theory that chronic irritation is an etiologic factor in the production of squamous-cell carcinoma Infection in this series of cases was not of sufficient frequency and duration to be considered as important as an etiologic factor

No cures were secured in three of the cases reported which indicates the necessity for early diagnosis In the fourth case, pathological examination showed early squamous-cell changes, and this patient is alive, two years after operation Again, the importance of early diagnosis is emphasized, that is, a diagnosis of kidney tumor and prompt treatment by removal of the kidney which preferably is preceded by radiation of the kidney The one case in which this procedure was followed resulted in failure, however, in the presence of a tumor as highly malignant as is epidermoid carcinoma of the kidney, we feel that all available remedial agencies possible should be used Roentgenologic examination of the chest should always be made in the presence of a suspected kidney tumor Chest metastases occurred in 50 per cent of our cases

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THE SIGNIFICANCE OF WEDGE-SHAPED DEFORMITY OF THE BODY OF THE VERTEBRA¹

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THE title refers to a narrowing of the anterior margin of the vertebral body so that, in a lateral roentgenogram, it appears to be triangular in shape instead of rectangular as is normal. This deformity occurs when the body of the vertebra becomes fragmented as in fracture crush, or when the bone becomes sufficiently softened from pathologic processes so that the body weight compresses the vertebra from

to the spinal column. Therefore, the downward thrust of the body weight would be greater at the anterior margin of the vertebra than at the posterior.

2 The interlocking processes between the vertebrae, and, in the dorsal region, the ribs also tend to support the posterior margin of the vertebra and prevent its collapse.

I am inclined to attach more significance



Fig 1 In fracture crush of the body of a vertebra in addition to the compression of the anterior border of the vertebra as demonstrated in the lateral view there is usually a widening of the vertebra laterally and a narrowing from above downward in the anteroposterior view. Intervertebral space is not involved.

above downward. Under these circumstances the effects of compression are greater in the anterior portion of the vertebra than in the posterior portion, producing the wedge-shaped deformity under discussion. This deformity is attributed to two factors.

1 The center of gravity of the body with the individual erect falls in a plane anterior

to the latter of the hypotheses. Many times I have observed cases of fracture crush of the body of the vertebra in which the roentgenogram made within a few hours of the accident shows the typical wedge-shaped deformity. As the patient had not been erect during the interval between injury and x-ray examination, it is obvious that body weight in the erect posture had no part in producing the deformity. Since we know, then, that the

¹ Read before the Pittsburgh Academy of Medicine, January, 1933.



Fig 2 When the nucleus pulposus is ruptured by traumatism the swelling of the nucleus causes a notched appearance on the opposing surfaces of the bodies of the vertebrae. The nucleus is also often displaced as in the case shown here

deformity can occur in the absence of factor No 1, it seems questionable what part this factor plays in producing the deformity

Let us consider now the differentiation between the various conditions producing this deformity. Beginning with fracture, we find that this is the only condition in which the deformity is due to fragmentation. However, this does not help us much since it is extremely seldom that one is able to distinguish the various separate fragments. Naturally a history of injury is very suggestive, but cannot be relied on too much, as fracture can occur from an injury which the patient may consider too trivial to mention, or the history may be unreliable from other causes. It is well to remember that in fracture the vertebra is often increased in width from side to side, as well as narrowed from above downward, and that a sharp angulation

both laterally and anteroposteriorly usually occurs at the site of fracture. By far the most common site of fracture is in the last two dorsal and first two lumbar vertebrae. In healed fracture, in cases in which the history is unreliable, the location and widening, with lateral angulation, are the most reliable signs. Recognition of callus cannot be relied upon. As a matter of fact, new bone deposit is much more common in certain inflammatory conditions than in fracture. The intervertebral space is usually normal in fracture.

Occasionally injury to the cartilage may occur, manifested by compression of the cartilage, with narrowing of the intervertebral space. The cartilage may become fractured, producing a similar effect. Injuries to the cartilage may result in disruption or dislocation of the nucleus pulposus, a very tough, elastic, round or oval body located about the center of the cartilage. Its function is to act as a fulcrum on which the bodies of the vertebrae pivot during anteroposterior bending of the spine. Violent injury may produce fracture of the cartilage, with disruption of the nucleus, which swells, due to its elasticity. It may be thrust against the opposing surface of the vertebra, producing a depression in the bone corresponding to the size and shape of the nucleus. Sometimes the nucleus is displaced backward in the cartilage and this displacement widens the intervertebral space posteriorly and interferes with the normal motion between the vertebrae. Accurate information regarding injuries to the cartilage are rather meager, and it seems certain that many such injuries have gone unrecognized in the past. The studies of Schmorl have recently stimulated interest in this field, and it seems probable that instructive observations and experiences will soon make their appearance in medical literature.

Another lesion of the vertebra occurring as a result of injury and one which has caused considerable confusion is the so-called Kummel's disease. Kummel reported this condition before the discovery

of x-rays, his knowledge of the condition being based on autopsy findings. Briefly, the condition is one of compression of the

that there can be no doubt of the identity of this disease. I have observed one such case and many others in which the history

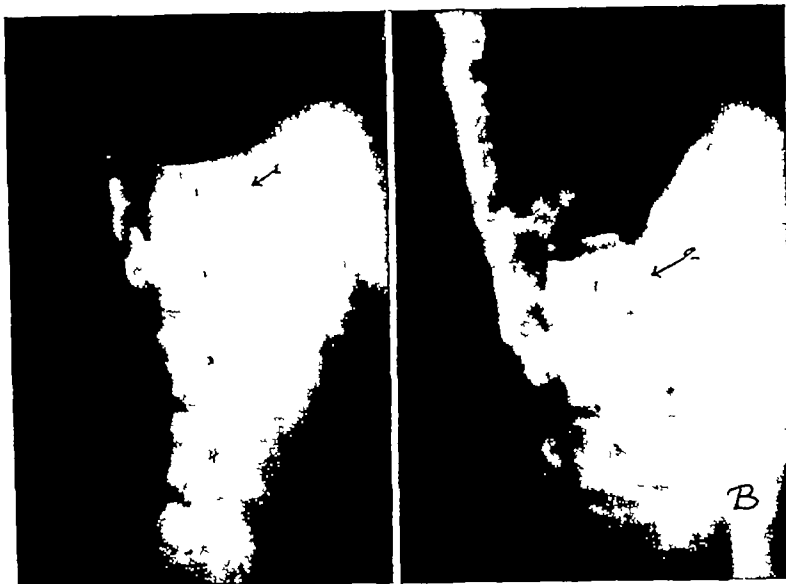


Fig 3 Kummel's disease (A) Note slight compression of the anterior margin of the body of the first lumbar vertebra, and the concavity of the anterior surface. This film was taken six months after the accident. (B) Film taken immediately after the accident does not show these changes.

anterior margin of the vertebra. Kummel thought the condition was due to a traumatic osteitis, with decalcification and softening of bone and a consequent deformity. The deformity does not make its appearance until two or more months following the injury. Many authors since Kummel have thought that the condition was really an unrecognized fracture crush, while others agree with Kummel. It is, of course, necessary to have x-ray films showing a normal vertebra immediately after the accident in order to identify Kummel's disease. As the accident is often trivial, x-ray films are usually not made. However, symptoms persisting, later x-ray examination shows the deformity. It is this peculiar set of circumstances which has produced so much confusion in Kummel's disease. However, a sufficient number of cases have been observed in which roentgenograms, made immediately following injury, were normal, while others, made later, showed the typical deformity, so

was identical with Kummel's disease, though the immediate x-rays were not taken. I believe the process is one of decalcification and not of unrecognized fracture. The deformity of fracture occurs immediately following injury, and I can see no reason why x-ray films taken at that time should not show it. I believe this condition occurs much more often than is generally believed. A study of the lateral films of the spine in any x-ray department is sure to reveal a number of cases in which one vertebra shows a wedge-shaped deformity. Investigation of such a case usually does not bring to light any history of serious injury, but the patient complains of pain in the back. As a matter of fact, the history is quite similar to the one *bona fide* case of Kummel's disease I have observed personally. The only thing that is lacking is the normal x-ray film made after an accident—if this had been made, quite probably further x-ray examination would have been considered superfluous, so that

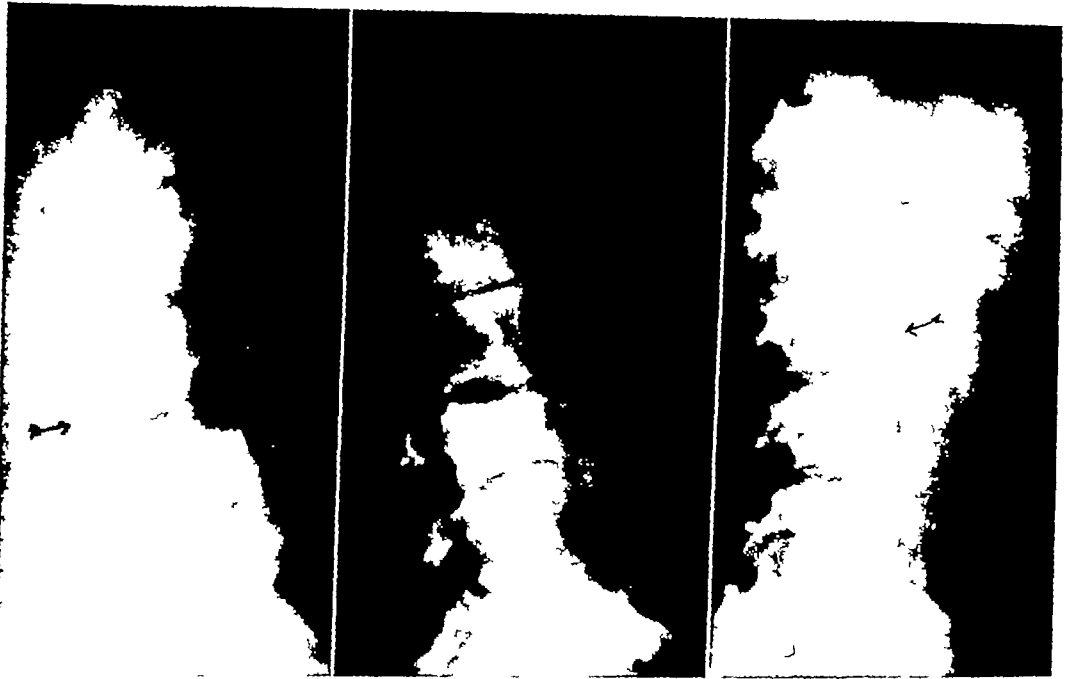


Fig 4

Fig 5

Fig 6

Fig 4 This is a case of very early tuberculosis selected to show the destruction of the cartilage which always precedes destruction of the bone. In a later stage the bodies of the vertebrae become destroyed and compressed along the anterior border.

Fig 5 Beginning compression of the body of the third lumbar vertebra in a case of metastatic carcinoma. In a later stage the body of this vertebra will become more completely destroyed.

Fig 6 There are various changes seen in syphilis of the spine—sometimes localized areas of destruction, sometimes new bone formation. The case illustrated here shows compression of the body of the second lumbar vertebra, due to rarefaction from a generalized osteitis.

the solution to this problem does not seem to rest with the roentgenologist. In any event, I feel that wedge-shaped deformity of a vertebra should always be accepted as abnormal and requiring explanation. It may not have any more clinical significance than calcified tubercles in the lung, but it certainly is not normal and should be explained to the satisfaction of the clinician before a final diagnosis is made.

Wedge-shaped deformity due to congenital malformation is usually seen in the dorsal or lumbo-sacral region. In the dorsal region, the incomplete vertebra is practically always a lateral wedge and not an anteroposterior one. It is usually accompanied by a lack of symmetry, or the absence of a rib. The fifth lumbar vertebra is normally wedge-shaped, being wider in front than behind. In cases in which a sixth lumbar vertebra is present, this is also shaped like the normal fifth lumbar. In-

identally, the presence of this extra wedge-shaped vertebra in this location predisposes to spondylolisthesis.

In considering deformity due to softening of the body of the vertebra, we find the lesions fall into two groups:

- 1 General decalcification due to constitutional causes
- 2 Local disease

Under general decalcification may be classified

- Posture curve
- Osteo-arthritis
- Osteomalacia
- Rickets
- Hyperparathyroidism

Lesions due to local disease are

- Tuberculosis
- Carcinoma
- Syphilis
- Paget's disease



Fig 7 Osteochondritis may, as in this case, involve only one vertebra when the lesion is very similar to Köhler's disease in the tarsal scaphoid. In other cases there is a slight compression of a number of adjoining vertebrae simulating a postural kyphosis.

Hodgkin's disease Osteochondritis

It is with some hesitation that I attribute the compression of a vertebra which occurs in posture kyphosis to decalcification. However, it seems to me that all the evidence would indicate that some softening of bone is present in these cases, both in the adolescent and in the aged. Probably no one will deny that decalcification and softening accompany the postural curvature which comes with senility, especially in cases in which this occurs in combination with osteo-arthritis. It is not customary to attribute the posture curve of youth to bone pathology, but when one considers that these children are practically all under par physically, it seems reasonable that the bones may be lacking in lime salts also and that the deformity of the vertebra is really due to a certain amount of softening and decalcification.

In osteo-arthritis, osteomalacia, and rickets, there is a general absorption of



Fig 8 In Hodgkin's disease, bone destruction in the spine is usually caused by pressure from enlarged lymphatic glands along the spine. In this case it is obvious that the lesion is a metastatic one involving the body of the first lumbar vertebra.

lime salts from the bones which results in compression of the bodies of the vertebrae, most pronounced along the anterior margins. The process usually involves the dorso-lumbar region first and, when other portions of the spine are involved, the changes are more marked in this location than elsewhere. In addition to the compression, cases of osteo-arthritis present bony deposits on the edges of the vertebra, which project as bony spur-like formations. These projections, together with the compression, change the anterior border of the vertebra from a plane surface to a



Fig 4

Fig 5

Fig 6

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more vertebræ may be involved. The process is more apt to occur in the lower dorsal region. Healing usually takes place spontaneously, the deformity being permanent. Another manifestation of osteochondritis seen in young children involves only one vertebra and is similar in many

respects to Kohler's disease of the tarsal scaphoid. The process is primarily an osteitis. There is, first, bone softening, with later compression of the body of the vertebra. The lesion heals by new bone formation, leaving the vertebra smaller, but more dense than normal.

concave one. This spur formation is peculiar to osteo-arthritis and is not seen in osteomalacia or rickets. The interarticular cartilage is apt to be narrowed in osteo-arthritis. However, in osteomalacia the cartilage assumes a bi-convex shape, thought to be due to a swelling of the nucleus pulposus brought about by the great elasticity of the nucleus and the lessened resistance of the greatly softened bone of the vertebra on each side. In osteomalacia, the decalcification is extreme.

In rickets and in hyperparathyroidism, the changes are similar to those in osteomalacia, but usually not so extreme. The differentiation between the three diseases is made by other means than roentgenograms of the spine. Rickets, of course, occurs only in children. Osteomalacia and hyperparathyroidism differ clinically, and the roentgenograms of other bones show somewhat different characteristics.

In tuberculosis there is actual bone necrosis which may go on to complete destruction of the bodies of one or more vertebrae. The interarticular cartilage is involved early. It soon becomes narrowed from destruction and may disappear entirely. In healing, it is not unusual for the bodies of adjoining vertebrae to become fused. Abscess formation is of common occurrence and if the involvement is in the dorsal region, this will show on the roentgenogram. Tuberculosis starts in one vertebra only and spreads from there by continuity to neighboring vertebrae. This is in contradistinction to other processes, which often appear simultaneously in different locations. When tuberculosis heals there is recalcification, but there is no deposit of excessive new bone as in syphilis, gonorrheal, or typhoid infection. Occasionally, cases of tuberculosis are seen in which the involvement begins centrally, and collapse of the vertebrae does not occur until there is very extensive involvement.

Metastatic carcinoma may involve one or more vertebrae simultaneously. As a result of invasion of the bone by the malignant growth it becomes weakened and collapses, the typical wedge-shaped deformity

following. The interarticular cartilage is not involved and the space between vertebrae is normal. Sometimes in metastasis from scirrhus carcinoma the invasion is so slow that the vertebra does not collapse but maintains its normal form, or perhaps becomes slightly compressed as a whole without assuming a wedge shape. There is no new bone formation in carcinoma.

In syphilis, as a result of osteitis, the bone becomes somewhat softened and compressed. The involvement is apt to be solitary, or limited to the vertebra immediately adjacent. The early appearance is quite like tuberculosis except that the cartilage is uninvolved. When the process heals, extensive deposits of new bone occur.

In Paget's disease the involvement is multiple, osteitis is present, and there is a generalized softening with deformity of several vertebrae. In addition, this process is characterized by localized deposits of excess calcium, which give the bones a mottled appearance. The differentiation of this disease is usually made by roentgenograms of the long bones, which present characteristic changes.

In late Hodgkin's disease, bone changes in the spine are not uncommon. They are usually due to pressure on the spine from enlarged paravertebral lymphatic glands. These changes are localized areas of destruction and not the wedge-shaped deformity we are considering. However, instances are occasionally seen in which metastasis undoubtedly occurs to the body of the vertebra and in these cases the involvement is exactly the same as in metastatic carcinoma. There is an extensive destruction of bone, the body of the vertebra collapses, and the typical deformity results.

Osteochondritis occurs in the adolescent. The process is a mild osteitis involving the cartilage, or the cartilage plate, the epiphysis, and the cartilaginous border of the vertebra. Slight erosion of the vertebra occurs, producing an irregular surface bordering on the cartilage. Softening of bone also occurs, with some compression of the anterior margin of the vertebra. One or

$$D = \frac{MT}{L^2} f_1(1 - f_2(ks + k_1w))$$

if expressed in Imc-hr, or by

$$R = 86 \frac{MT}{L^2} f_1(1 - f_2(ks + k_1w))$$

if expressed in roentgens²

M in these formulæ is the quantity of radium element (not the radium compound) in the needle in milligrams (Certificates of radium needles issued by the national laboratories do not usually state M directly. For example, the needle may be said "to emit radiation equivalent to 0.95 mgm radium," and a footnote on the certificate may state further that it is estimated that 5 per cent of the radiation is absorbed in the needle walls. For such a needle, therefore, M would equal 1.00 mgm.)

T is the time of exposure in hours

L is the length in centimeters of the cavity in the needle (not the total length of the needle), which is filled with radium. If not known, it is easily found by making a contact print of the needle by its own radiation on x-ray film. A few seconds' exposure will produce a black line on the film which is only very slightly longer than L .

s is the effective thickness of the needle wall in millimeters. To sufficient accuracy it equals the actual thickness increased by $5/33$ of the inner radius of the wall, i.e.,

$$s = r_2 - \frac{28}{33}r_1 \quad r_2 \text{ and } r_1 \text{ are the outer and}$$

inner radii, respectively

k is the absorption constant of the material comprising the needle wall, values of which are given in Table I

f_1 and f_2 are numbers which depend on the position of the point. f_1 is obtained from Figure 2, and f_2 from Figure 4

f_1 and f_2 are plotted in terms of $\frac{\lambda}{L}$ and $\frac{w}{L}$

The significance of these may be seen from Figure 1. L , as before, is the active length

of the needle, w is the distance of the point from the axis of the needle, and λ is its distance from the plane which cuts the needle axis perpendicularly through its center

TABLE I—ABSORPTION COEFFICIENTS FOR THICKNESSES OF MATERIALS IN MILLIMETERS

Aluminium	0.007/mm
Lead	0.088
Platinum	0.139
Iridium pt	
Gold	0.140
Silver	0.043
Monel	0.021
Muscle	0.0024
Epithelial tissue	
Bone	0.0055
Water	0.0026
Rubber (lead free)	0.0023
Soft wood (pine)	0.0013
Hardwood (ash)	0.002
Paraffin wa	0.0022
Glass (lead free)	0.007

Part of Figure 2 is reproduced on large scale in Figure 3

k_1 is the absorption coefficient of the biological tissue. For epithelial tissue and muscle, $k_1 = 0.0024$ if w is given in centimeters. Within 1 cm of the needle, k_1w may be considered negligibly small and may be omitted

Example—The 10 mgm needle shown in Figure 1 was applied for 10 hours. It is required to find the dose at the point P , 0.75 cm from the axis, and 3.0 cm from the central plane

Wall material, iridium platinum, hence from Table I

$$k = 0.14/\text{mm}$$

Outside diameter, 3 mm, inside diameter, 2 mm, therefore

$$s = \frac{1}{2} \times 3 \text{ mm} - \frac{28}{33} \times \frac{1}{2} \times 2 \text{ mm} = 0.65 \text{ mm}$$

Length of radium cavity, $L = 1.5 \text{ cm}$, $w = 0.75 \text{ cm}$, $\lambda = 1.5 \text{ cm}$,

$$\text{Therefore, } \frac{\lambda}{L} = 1, \frac{w}{L} = \frac{1}{2}$$

Referring to Figure 2, it may be seen that the co-ordinates

INTENSITY AND DOSAGE NEAR RADIUM NEEDLES¹

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From the National Research Council of Canada

Part I

INTRODUCTION

IT HAS been customary to describe radium treatments in milligram-hours, the product of the quantity and time of application of the radium. The number of milligram-hours required to produce the desired effects varies between wide extremes, depending on the distance of the radium from the tissue and other factors. Therefore, comparisons in milligram-hours without further information are of little significance except in questions of economy.

The practice of radiology is based on the supposition that similar results under

skin and the tumors, is a useful specification of the physical treatment.

The "dose" at a point in the tissue is the number of roentgens or Imc-hr traversing the region of point during the irradiation. This quantity is not easily measured on every occasion. It is practicable, however, to select a number of arrangements of needles which are frequently used, to determine the dose near them, and to tabulate this information in convenient charts for ready reference in routine work. This has been done at the Radiumhemmet, Stockholm, the Memorial Hospital, New York City, and elsewhere (1). The charts which they have prepared are not always applicable in other institutions where needles are used of different design, and in different arrangements. This paper gives formulæ and graphs from which can be determined easily the dose at any point near any needles with sufficient accuracy for therapeutic purposes. It is possible to construct from this, dosage charts for combinations of needles with much less labor than is involved in the corresponding laboratory measurements, or in calculation from first principles. A useful set of charts may be prepared in a few hours.

Part I of the paper is restricted to the practical details of the method of determining the dose at a point near a radium needle or tube, and of preparing charts of the distribution of the dose near a combination of needles. Theoretical discussion of the derivation of the formulæ and data and other questions is given in Part II.

THE DOSE AT A POINT NEAR A RADIUM NEEDLE

The dose at a point P near a radium needle or tube is given by

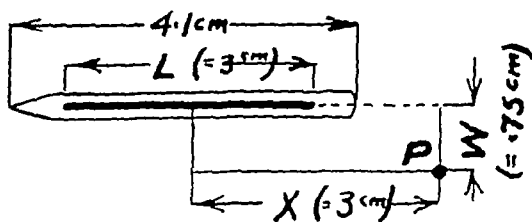


Fig 1

similar conditions tend to follow similar physical disturbances. Therefore, it is sensible to discuss directly the disturbance—that is, the irradiation—rather than the milligram-hours necessary to produce it. The practice is growing of describing radium therapy in terms which are a measure of the actual amount of irradiation applied. Two units of the quantity of irradiation have been used for this purpose: the roentgen, which is familiar in x-ray therapy, and the milligram-hour per centimeter squared (abbreviated Imc-hr). Statement of the irradiation in these units, in addition to full description of radium needles and their position relative to the

¹ Presented before the Radiological Society of North America at the Twentieth Annual Meeting at Memphis, Tenn. Dec 3-7 1934

$\frac{v}{L} = 1$ and $\frac{w}{L} = \frac{1}{2}$ intersect at the curve
 $f_1 = 0.94$

might be based on the determination of the dose at 20, 40, or more points This requires considerable calculation Much

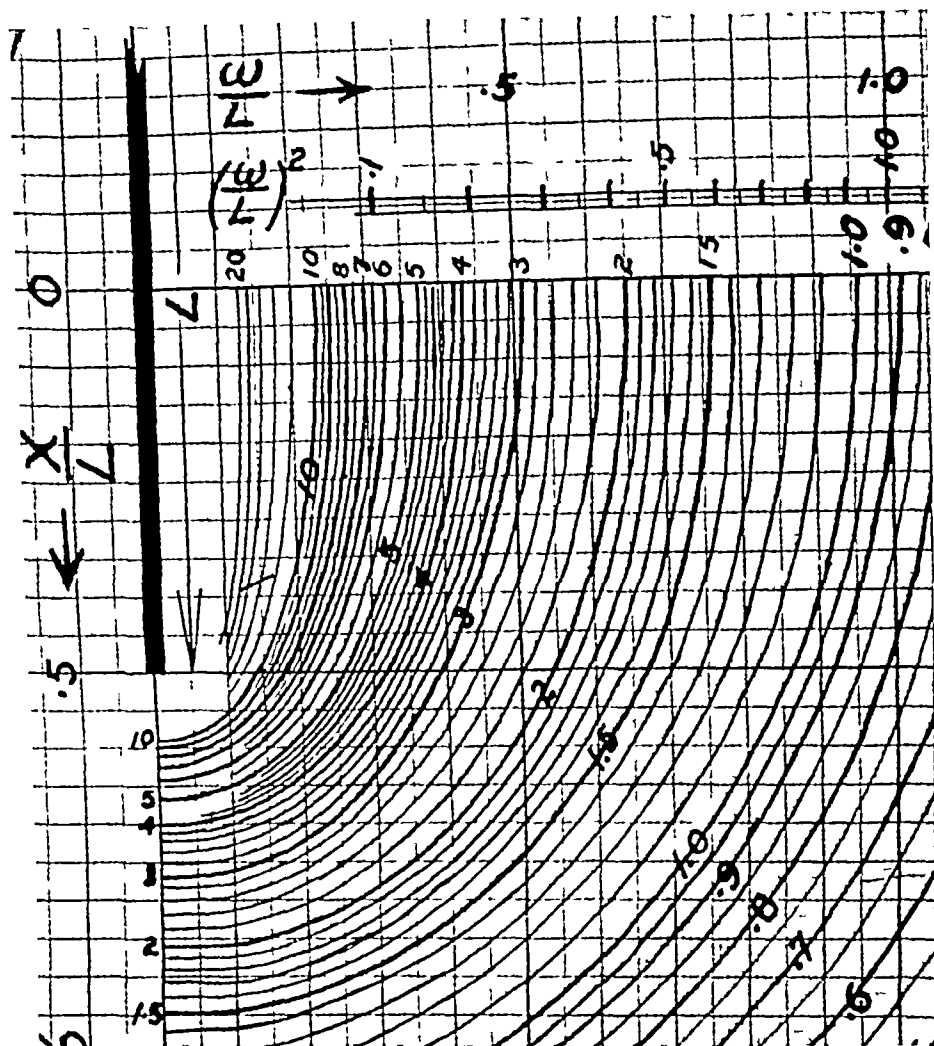


Fig 3

Similarly from Figure 4, $f_2 = 2.0$
 Therefore,

$$R = 8.6 \frac{r}{\text{Imc-hr}} \times \frac{10 \text{ mgm} \times 10 \text{ hours}}{1.5 \text{ cm} \times 1.5 \text{ cm}} \times 0.94 \times (1 - 2.0 \times (0.14/\text{mm} \times 0.65 \text{ mm} + 0.024/\text{cm} \times 0.75 \text{ cm})) = 282 \text{ roentgens}$$

If several needles are present, the total dose is obtained by adding together the doses due to the needles individually

PREPARATION OF DOSE CHARTS

A useful diagram of the distribution of dose near an arrangement of several needles

unnecessary work can be avoided by suitable choice of points, by systematic arrangement of calculations, and by tabulating the results of each part of the calculation. Suggestions about how this may be done is the subject of this section.

The pattern of 14 needles shown in Figure 7 will serve as an illustration. It consists of 10 milligram needles, with 0.5 mm walls of iridium platinum. The needles are spaced 1 cm apart in two rows. The two rows are separated 1 cm between

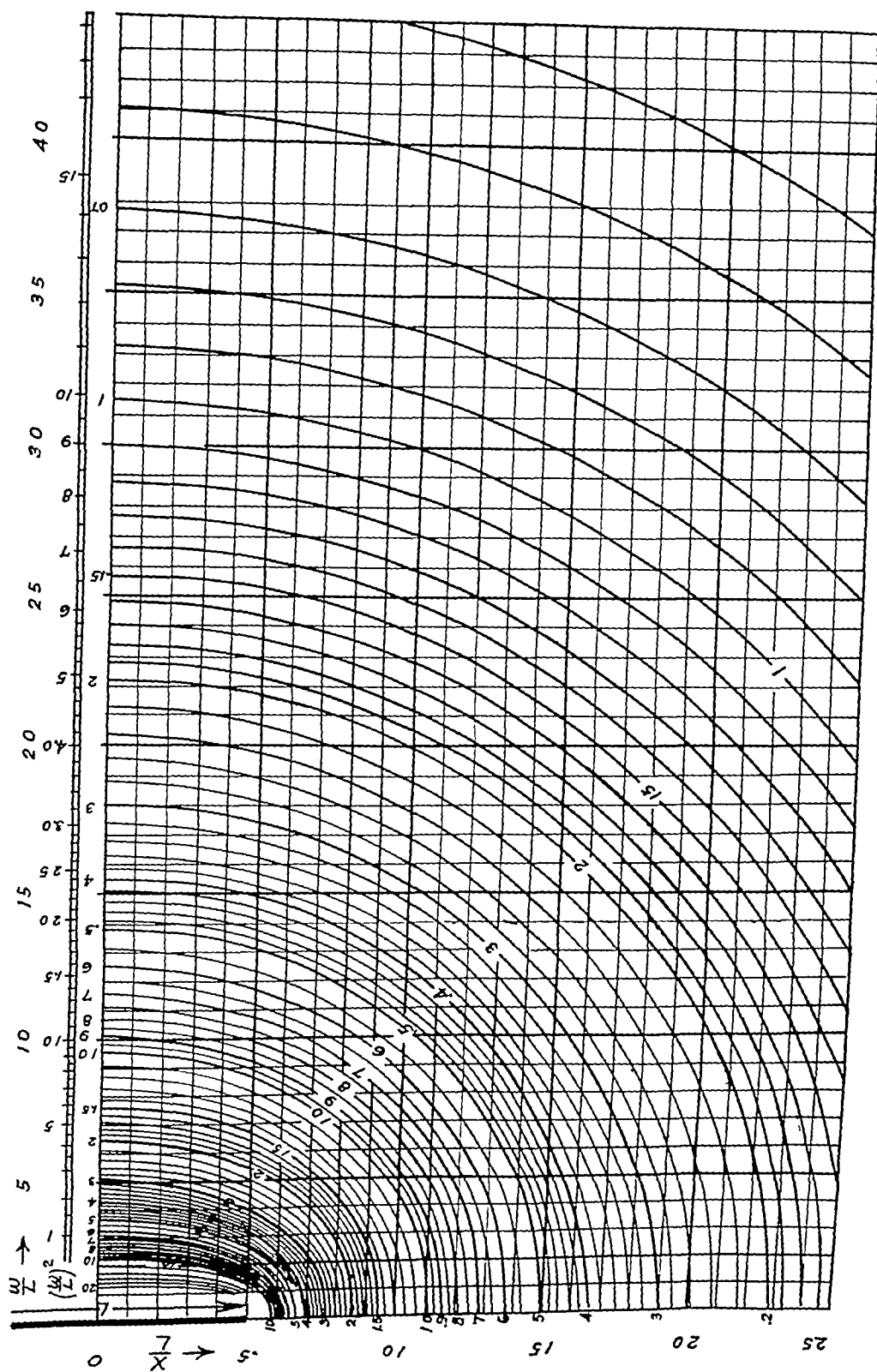


Fig 2

24 cm, 30 cm, 36 cm, 45 cm, and 60 cm, that is, at 81 points in all (Fig 10) Since the corresponding points under the four d 's are alike, and this is true also of the

lation has been reduced to a little more than a quarter of what it would otherwise be

It is convenient to proceed in the follow-

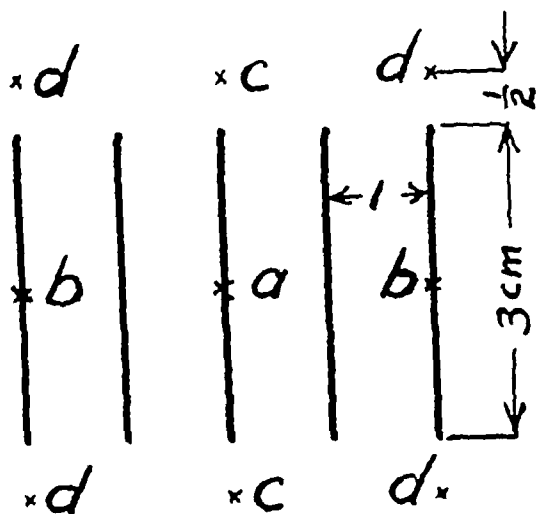


Fig 5

two b 's and two c 's, the number of values to be calculated is reduced to 36

Figure 10 illustrates one kind of dose chart. In it are represented values of the dose at points under one each of the d 's, b 's, c 's, and a . Other types of dose chart may be suggested, for example, a suitable vertical plane may be chosen such as through cac or through bab . A set of equal dose (isodose) curves may be drawn in freehand with tolerable accuracy, using the 81 points for guidance. Examples of charts of this kind may be found in some of the papers already cited.

It may be observed that at points under b and a the value of λ is 2 cm for every needle. The positions of d and c were chosen so that λ is again 2 cm for the nearest row of needles. Therefore, the effect of the upper row of needles on the point at a particular depth below b' is equal to its effect on the point at the same depth under d . Similarly the positions a , b' , c' , and d' are such that at a given depth below these four points, effects of the upper left-hand needles are equal. Thus by a suitable choice of points the amount of calcu-

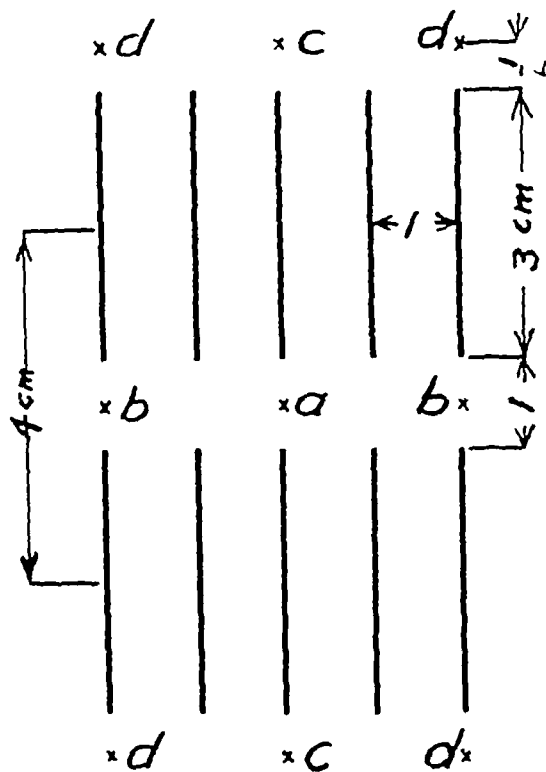


Fig 6

ing manner. One depth (e.g., 0.6 cm) is considered at a time. The dose at this depth under d is derived first. If the needles are alike, the first part of the formula, $\frac{MT}{L^2}$ is common to all of them. Multiplication by this factor can be postponed until the values for the rest of the formula, $(1-f_2(ks + k_1w))$, have been calculated for each needle and added together. As $(1-f_2(ks + k_1w))$ is evaluated for each needle it is carefully noted in a little table with a space for each needle.

The dose at the same depth under b is found now by adding up the appropriate values of $(1-f_2(ks + k_1w))$ and multiplying the sum by $\frac{MT}{L^2}$. These values of $(1-f_2(ks + k_1w))$ do not have to be calcu-

centers The active length of the needle (length of the radium core) is 30 centimeters The over-all length is 42 cm, but this fact is irrelevant

Nine points, marked *a*, *b*, *c*, and *d*, are chosen in the plane of the needles The dose is determined at nine depths below each point, 0.6 cm, 1.2 cm, 1.8 cm,

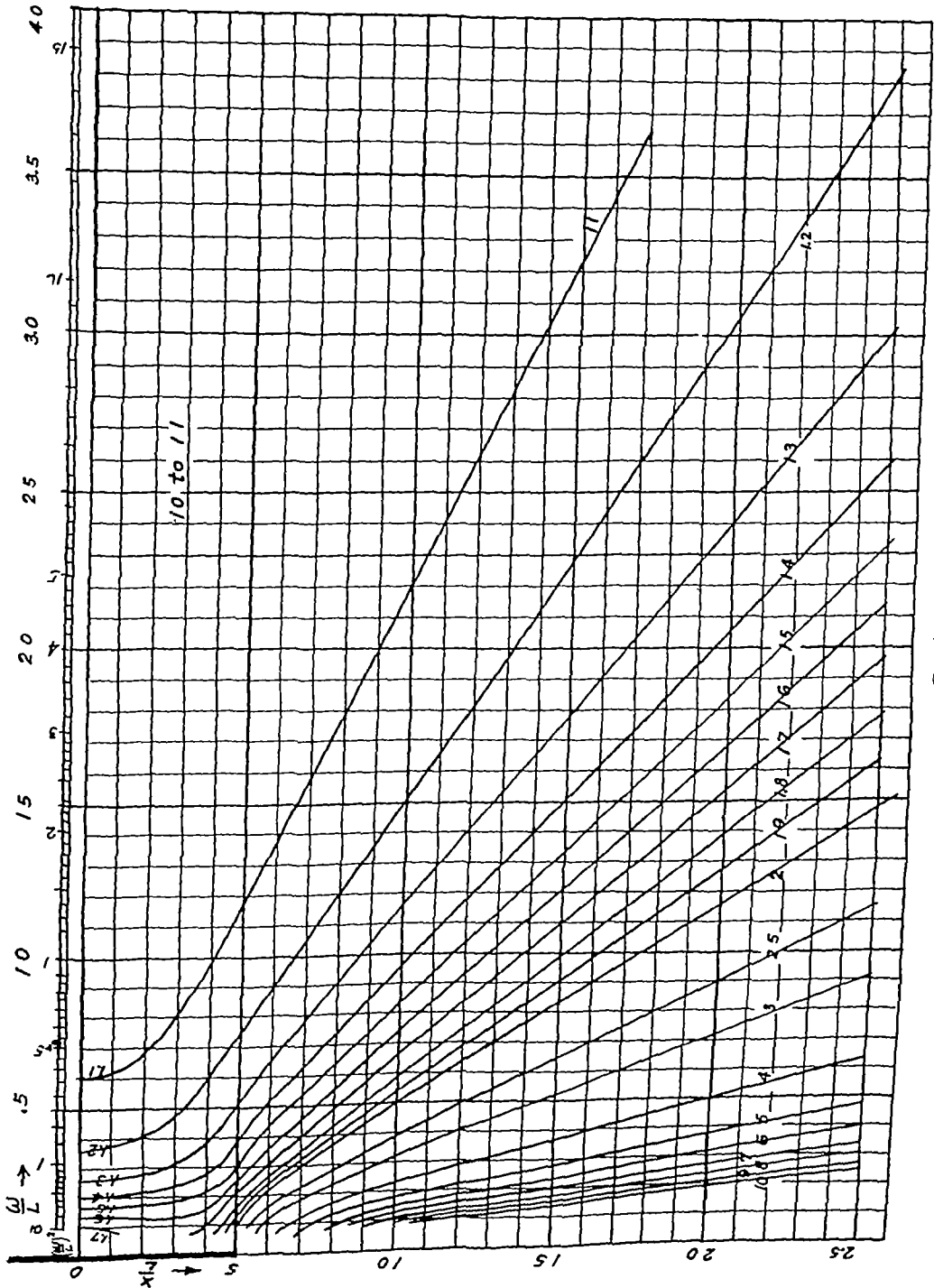


Fig 4

which the chart is intended. It is important, therefore, to know how much change in needle design may be permitted without not be great enough to alter this distance by more than 10 per cent. It should be noticed that this criterion permits very little

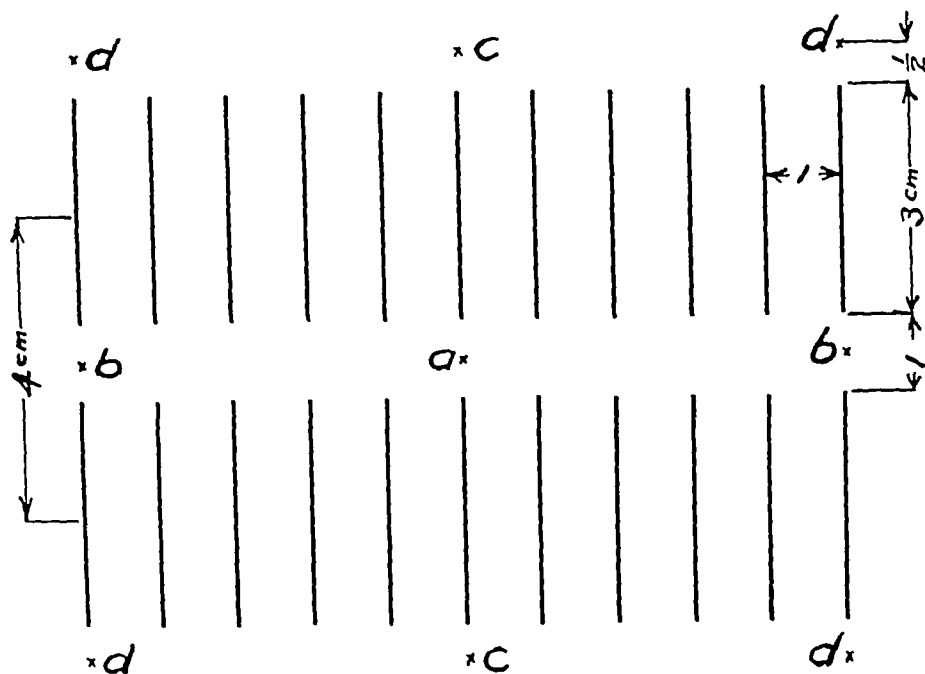


Fig 5

producing excessively large differences in the actual dose from values indicated in the chart

A change in M , the amount of radium in every needle, or T , the time of exposure, offers no difficulty. The dose is altered in proportion to the change in M and T .

A change in L or sk produces a change in the dose which depends on the position of the point. The following general statements indicate approximately the size of these changes. (A tolerance of 10 per cent is assumed for purposes of illustration only.)

In combinations of needles similar to the one described, that is, a number of needles all in one plane and equally spaced in parallel rows, the following empirical rule is a rough indication in the permissible change in L such that the dose at a point is not altered by more than 10 per cent. The distance of the point from the nearest end of the active length of the nearest needle should be measured. The change in L must

change in L for points near the end of a needle, but permits quite large changes in L for points some distance away.

The values of the dose can be partly corrected for a change in sk by dividing them by $(1 - sk)$ and multiplying by $(1 - s'k')$ where sk and $s'k'$ are characteristic, respectively, of the needles of the chart, and the new needles. When thus corrected, the dose may be considered to be in error by less than 10 per cent if the value of $(1 - f_2sk)$ at the point for the nearest needle to it has not been altered by more than 20 per cent. It follows that very little change in sk is permissible at points situated beyond the ends of the nearest needles in direction at small angles from their axes.

If the inactive ends of the needles are long, it may be desirable to overlap slightly the ends of needles in different rows to avoid a large inactive gap between rows. This involves placing the needles in an oblique position by rotating them slightly about their center, but does not introduce

lated They can be found in the table already prepared for the point under *a*, because every needle has the same position

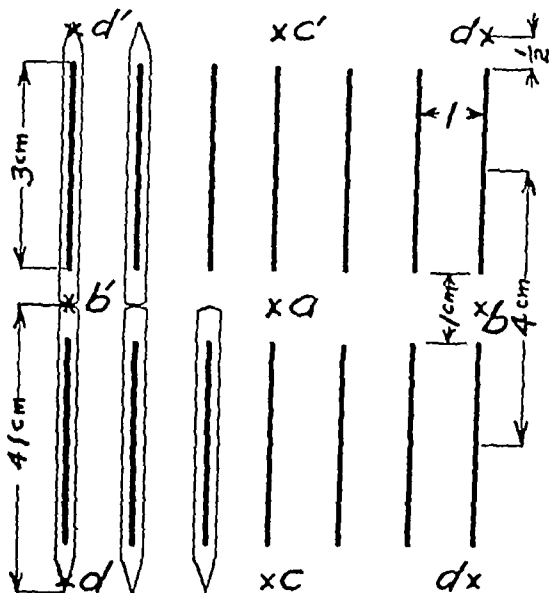


Fig 7

relative to the point under *b*, as some needle had to the point under *a*. This is true also for *c* and *d*.

Having completed one chart it is very easy to construct another chart for a smaller number of needles of the same design and spaced by the same intervals. The necessary values of $(1 - f_2(ks + kw))$ are already available in the tables prepared during the calculation of the first chart. On the other hand, if the number of needles is increased $(1 - f_2(ks + kw))$ must be calculated for the extra needles only.

The most tedious part of the calculations is the evaluation of $(1 - f_2(ks + kw))$ for each needle. *w*, which is required to obtain *f* and *f₂*, is most easily determined by actual measurement on a drawing to scale. If this drawing is an elevation perpendicular to the axes of the needles, and of such a scale that *L* is represented by 1 cm, then *w* is given directly by the distance from needle to point, measured in centimeters by a centimeter scale. Graph paper is convenient for making drawings of this kind to scale.

The accuracy of these charts is sufficient for therapeutic purposes. Great accuracy offers no advantages in radium therapy because

- (1) it is not possible to measure distances in tissue accurately,
- (2) the boundary of a tumor is not sharply defined, and
- (3) there are biological variables which cannot be controlled as accurately.

At points within 0.5 cm of the needle axis, the method is inaccurate. This is due in part to the effects of beta rays from the metal walls of the needles. The dose so close to the needle is of little interest and must be interpreted cautiously, because very little is known about the extent to which the individual cell is influenced by effects on neighboring tissue, a question of great importance when the gradient of the ionization intensity is large.

It has been assumed in the derivation of the formulae that practically no beta rays from the walls of the needle reach the point *P*. This is assured if at least 5 mm thickness of flesh, wood, wax, rubber (lead-free), or similar material lies between the needle and the point. Hence if the radium needles are applied externally, the charts will give the dose on the surface of the skin only if a layer 5 mm thick of such material is placed between the skin and the needles. The absorption in this layer is small and may be ignored. This layer has the additional advantage of reducing the skin dose necessary for a given tissue dose.

The dose due to a needle becomes inaccurate also when either *f₂* exceeds 10 or *f₂ks* exceeds 0.4. This is due partly to the absorption in the ends of the needle and partly to mathematical approximations in deriving the formula. It sometimes occurs in computing charts for a combination of several needles. Although the calculated effect of the particular needle is inaccurate, the error is a very small part of the combined effect of all needles and, therefore, the accuracy of the chart is little affected.

Occasion may arise for using needles differing somewhat in design from these for

TABLE IX—DOSE IN ROENTGENS IN ONE HOUR 3 TUBES IN LINE, 2.25 CM APART, AS IN FIGURE 9, 10 MG TUBES, ACTIVE LENGTH 1.5 CM, OUTSIDE DIAMETER 2.5 MM, WALL OF IRIDIO-PLATINUM 1.0 MM THICK

mm	a	b	c
6	169 r	160 r	100 r
12	65	57	43
18	37	32	25 1
24	24 8	20 5	17 2
30	17 7	14 9	12 7
36	13 2	11 3	9 7
45	9 0	7 9	6 9
60	5 3	4 7	4 3
75	3 2	3 0	2 8

thin, a unit is obtained which is several times larger than one based on measurements which exclude the effects of the very soft radiation. Therefore, it is necessary to give further details in the definition.

Kohlrausch has shown that the hard radiation from radium in equilibrium with its disintegration products may be considered to consist of three Groups, I, II, and III, of different absorption coefficients. (2) All softer radiation may be included in a fourth Group, IV.

It is of considerable advantage to avoid the effects of Group IV in defining the unit, for reasons to be considered later. This, of course, would not be justified if it were not for the fact that the amount of Group IV in the radiation which has penetrated the walls of needles and tubes of ordinary design is practically negligible.

The *Imc-hr* is, therefore, defined as the dose resulting in one hour from the three Kohlrausch Components of quality only in the radiation emitted from one milligram of radium at a distance of one centimeter.

The unit is realized by measurements made under conditions in which Group IV, the primary beta rays, and the secondary beta rays from any material of high atomic number such as the needle wall, are excluded. The measurement is then corrected for distance from the source by the inverse square law, and for absorption of Groups I, II, and III in the walls of the radium standard and the ionization chamber. For this purpose an ionization cham-

ber with an inner wall of 5 mm aluminium and an outer wall of 0.5 mm lead has been used. The outer wall eliminated Group IV and the inner wall eliminated the secondary beta rays from the outer wall. Measurements were made also in chambers of wide variety of materials to test the assumptions made in this work, and to obtain values of the absorption coefficients of various materials under various conditions.

There are two advantages in using only Groups I, II, and III and excluding Group IV.

(1) Measurements of absorption coefficients are independent of the nature of the material of the inner wall of the chamber, provided that it is of low atomic number, thick enough to exclude secondary beta rays from dense material outside, and correction is made for the absorption in the wall itself. This is important because the only experimental quantities which enter directly into the realization and use of the *Imc-hr* unit are absorption coefficients.

(2) The conversion of *Imc-hr* into roentgens is simplified, because the effects due to the walls of the chamber are equal to the effects which would be produced by a large surrounding body of air as required by the definition of the roentgen. This is discussed in more detail in the next section.

Although foreign to the subject of this paper, it is interesting also that the secondary physical effects in biological tissue are proportional to the dose in roentgens due to these three quality groups, regardless of their relative intensities.

These advantages result from the fact that the absorption of Groups I, II, and III in materials of low atomic number is due practically entirely to the Compton effect. This is explained as follows:⁴

Gray (3) has shown that the Compton effect with hard gamma rays is not appreciably affected by the forces binding electrons to atoms, and that the probability of

⁴ To avoid much repetition in this chapter light material will mean material of low atomic number only and hard gamma rays will refer to the radiation of Groups I, II, and III only.

objectionable error at depths greater than three times the diameter of the needles

If the surface containing the needles is curved slightly (*e g*, in superficial application to the breast) dosage on the concave

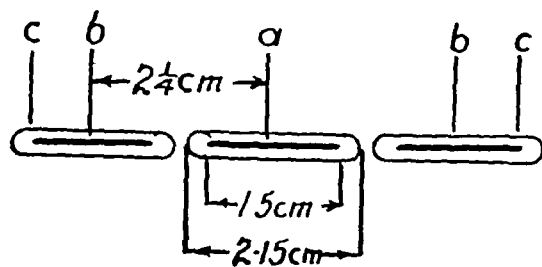


Fig 9

side is slightly increased. The increase is negligibly small at depths less than 2 or 3 cm unless the curvature is very pronounced.

The following diagrams and tables apply to needles containing 10 mgm radium, outside diameter 2.5 mm, wall of iridio-platinum 0.5 mm thick, effective length (*L*) 3 centimeters. They are placed 1 cm apart in rows separated 4 cm between centers. The figures in the tables are the doses resulting one hour at various depths below the designated point on the diagram. The lines in the diagrams represent the cavities in the needles which contain the radium.

TABLE V^a—DOSE IN ROENTGENS IN ONE HOUR 5 NEEDLES, 1 CM APART, AS IN FIGURE 5, 10 MG NEEDLES, ACTIVE LENGTH 3 CM, OUTSIDE DIAMETER 2.5 MM, WALL OF IRIDIO-PLATINUM 0.5 MM THICK

mm	a	b	c	d
6	220	174	82	64
12	116	88	60	47
18	70	55	44	35
24	47	37	33	26.4
30	32.5	26.7	24.6	20.6
36	23.6	20.2	19.0	16.5
45	15.7	13.7	13.4	11.8
60	9.0	8.2	8.0	7.3
75	5.7	5.4	5.3	5.0

Part II—*Imc-hr* as the Unit of Dose

One milligram-hour per centimeter squared, abbreviated *Imc-hr*, is the dose

^a There are ten figures and six tables. The latter are numbered I V VI VII VIII IX. Table V is so numbered because it refers to Figure 5, similarly for Tables VI to IX.

TABLE VI—DOSE IN ROENTGENS IN ONE HOUR 10 NEEDLES, 1 CM APART, IN TWO ROWS, 4 CM BETWEEN CENTERS, AS IN FIGURE 6, 10 MG NEEDLES, ACTIVE LENGTH 3 CM, OUTSIDE DIAMETER 2.5 MM, WALL OF IRIDIO-PLATINUM 0.5 MM THICK

mm	a	b	c	d
6	165	128	90	71
12	120	94	68	55
18	88	70	62	43
24	64	53	40	34
30	49	41	32	27.4
36	38	33	25.5	22.5
45	26.7	23.5	19.0	16.9
60	16.0	14.6	12.4	11.6
75	10.5	9.9	8.6	8.3

TABLE VII—DOSE IN ROENTGENS IN ONE HOUR 14 NEEDLES, 1 CM APART, AS IN FIGURE 7, 10 MG NEEDLES, ACTIVE LENGTH 3 CM, OUTSIDE DIAMETER 2.5 MM, WALL OF IRIDIO-PLATINUM 0.5 MM THICK

mm	a	b	c	d
6	186	136	104	72
12	139	102	82	61
18	105	78	64	48
24	79	60	50	39
30	62	47	40	32
36	49	39	33	27.0
45	35	28.1	25.0	20.6
60	21.2	18.2	17.0	14.8
75	14.3	12.7	11.8	10.7

TABLE VIII—DOSE IN ROENTGENS IN ONE HOUR 22 NEEDLES, 1 CM APART, AS IN FIGURE 8, 10 MG NEEDLES, ACTIVE LENGTH OF 3 CM, OUTSIDE DIAMETER 2.5 MM, WALL OF IRIDIO-PLATINUM 0.5 MM THICK

mm	a	b	c	d
6	209	143	121	83
12	161	108	96	66
18	126	84	78	54
24	98	66	64	44
30	78	54	53	37
36	64	45	45	32
45	47	34	35	25.5
60	30	22.6	24	18.5
75	20.5	16.4	17.3	14.0

resulting in one hour from the gamma rays emitted by one milligram of radium at a point one centimeter from the radium. The size of this unit depends greatly on the nature of the radium container and the manner in which measurements are made. For example, if the walls of the radium container and the ionization chamber are very

beta ray of a particular velocity is nearly proportional to the number of electrons per unit volume also. In the terminology of Bohr's theory of collisions (5), the rate of loss of energy depends on the average value for all electrons of the logarithms of their characteristic frequencies. This, however, appears to be nearly constant for different elements (6).

It follows that in light materials the product of the number of secondary beta rays and their true range is nearly constant. If these beta rays were straight (did not receive large angle deflections), it is evident that the number, velocity, and directional distribution of the beta rays crossing unit area of the boundary of such a material would be independent of the atomic number of the material, provided that the dimensions of the material are larger than the ranges of the beta rays in it. That is, the number, velocity, and direction of the beta rays from the walls of an ionization chamber would not depend on the material of the wall if it were free from elements of large atomic number.

The large angle deflections in the paths of the beta rays are chiefly due to encounters with the nucleus and, therefore, vary rapidly in number with atomic number. Since these nuclear collisions absorb comparatively little energy from the beta ray, the number and velocity of the beta rays are practically unaltered but the directional distribution depends greatly on the atomic number of the substance. If a hole is made in a large volume of the substance, the number and velocity of the beta rays crossing unit volume in this empty space are independent of the material. The direction of the beta rays is greatly dependent on the material. Therefore, in a small ionization chamber the number of beta rays from any *one* wall of the chamber depends on the material, but the total number of beta rays from *all* walls does *not*. It follows that the ionization current in the chamber is independent of the nature of the walls if the following conditions are satisfied.

(1) Chamber dimensions are small com-

pared with the distance to the radio-active source, and the absorption in the walls is small, so that the intensity of the radiation is practically the same in all walls.

(2) Wall thickness is greater than the ranges of most of the beta rays in the material.

(3) Chamber walls are made of matter of low atomic number.

(4) Groups I, II, and III only are present in the radiation and Group IV is excluded by filtration.

Accordingly, definitions of units and methods of measurement have been adopted which satisfy these four conditions and thereby lead to the two advantages mentioned earlier.

Experimental proof of these conclusions is given by the measurements of Kohlrausch and Schrodinger (7). They measured the ionization in the two halves of an ionization chamber subdivided symmetrically by a partition of the metal under investigation. They found that the contribution to the ionization in the air in the chamber from the two sides of the thick metal partition is independent of the material to within 2 per cent for a series extending from Al (At No 13) to Zn (At No 30). (Suitable correction for absorption in the metal was made, of course.) The contribution increases with metals heavier than Zn, as may be expected from the occurrence of photo-electrons.

While this indicates that the total contribution from *all* the walls of the chamber is independent of their material, the contribution from any *one* wall *does* depend on the material. Due to the large angle scattering, the contribution of the "far" wall increases and that of the "near" wall decreases with atomic number. Confusion of the effect of a single wall (or other surface) and of all the walls has led to unjustified criticism of this method of measuring gamma rays.

Unfortunately Kohlrausch and Schrodinger's tests did not include materials of atomic number less than 13. Extrapolation in that direction may be made fairly confidently, for the influence of nuclear

a Compton collision depends only on the electron density of the material, and is proportional to it

The measurements of Madgwick (4) and others have shown that the decrease in energy per unit distance travelled by a fast

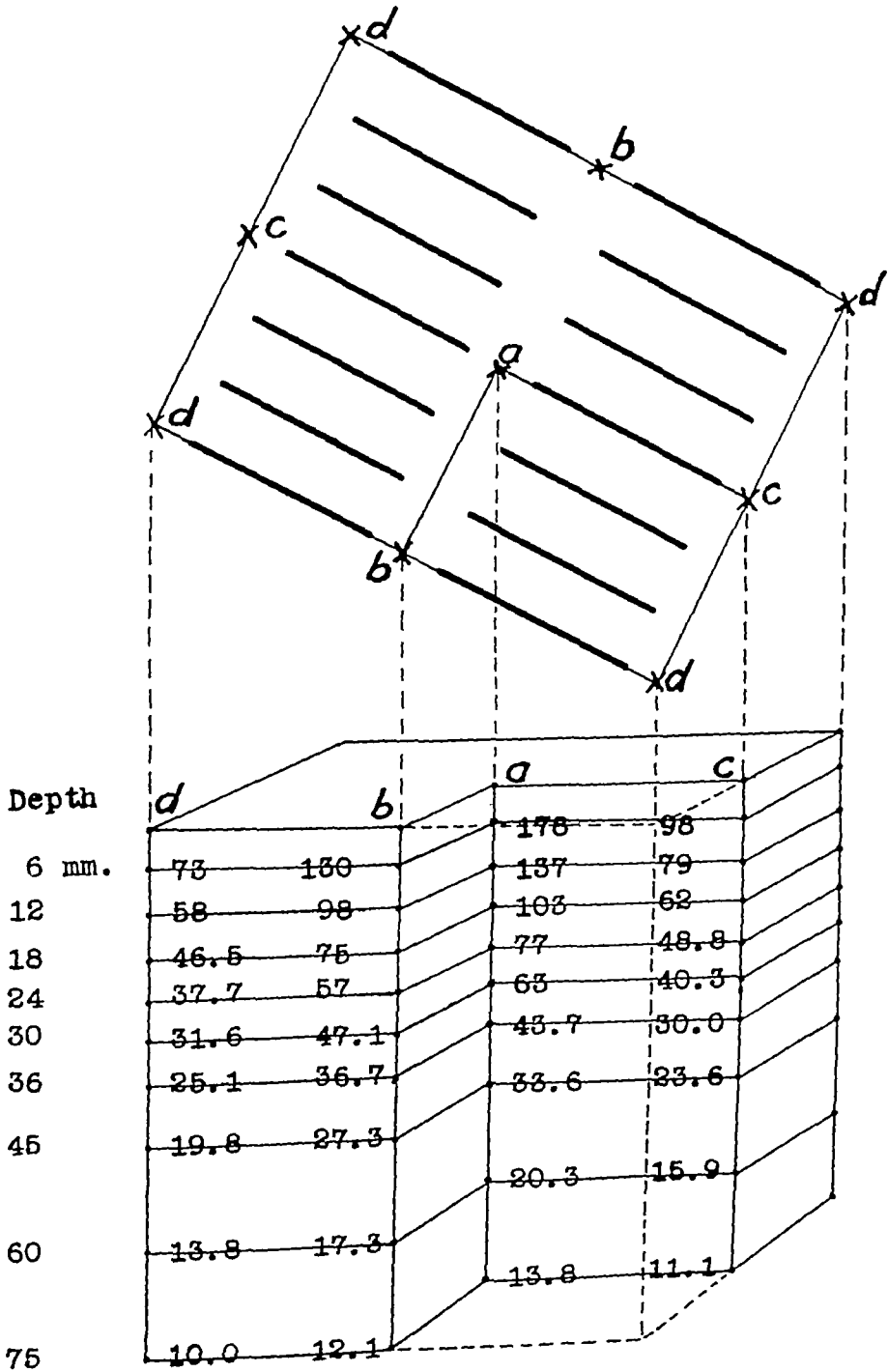


Fig 10

tically a constant on account of the definition which has been chosen, provided that soft gamma rays and beta rays from the needle or massive material are filtered out. This condition is fulfilled if the needle wall thickness exceeds 0.3 mm of platinum or the equivalent, and the point P is separated from the needle wall by more than 0.4 mm of flesh, wood, or similar material.

DERIVATION OF FORMULAE AND TABLES

Assume that the axis of the radium needle lies along the ν -axis of a system of cartesian co-ordinates. The quantity of radium is uniformly distributed throughout the length of the needle cavity from $\nu = \frac{-L}{2}$ to $\nu = \frac{L}{2}$. The needle wall has an effective mean thickness (see below) s and the absorption coefficient is k . The absorption coefficient of flesh is k' . Dose is to be calculated at point $P(\nu_1, y_1, z_1)$ in a time T .

Assume that radium is concentrated as a line source of infinitesimal thickness along the needle axis. This assumption produces an error of less than 1 per cent if the distance of P from the needle axis is over four times the diameter of the needle cavity.

Ignore the absorption in the radium and inert packing. This is usually much less than 1 per cent.

Ignore "end-effects" in the needle wall, i.e., regard it as an infinite hollow tube. This will only introduce appreciable error if P is situated beyond one end of the needle in a direction from the center, making a small angle with the axis.

The element of dose (in Imc-hr) at $P(\nu_1, y_1, z_1)$ in time T , due to an element of length of the radium source between ν and $\nu + d\nu$, is

$$\alpha D = \left\{ \frac{MT}{L} d\nu ((\nu_1 - \nu)^2 + w^2) \right\}$$

erision. However since this modification of the unit was entirely arbitrary it has been abandoned.

$$\exp \left\{ - \frac{(ks + k_1 w)}{w} ((\nu_1 - \nu)^2 + w^2)^{\frac{1}{2}} \right\}$$

where

$$w^2 = Y_1^2 + z_1^2$$

The exponential term on the right, which represents the absorption in the needle wall and flesh, may be replaced by the first two terms of the series expansion

$$1 - \frac{ks + k_1 w}{w} ((\nu_1 - \nu)^2 + w^2)^{\frac{1}{2}} + \text{etc}$$

Error due to this approximation does not exceed 2 or 3 per cent with ordinary needles, except at points beyond the end at small angles from the needle axis, as in the case of end-effects.

Integration between $\nu = \frac{-L}{2}$ and $\nu = \frac{L}{2}$ yields for the total dose in Imc-hr

$$D = \frac{MT}{L^2} f_1 (1 - f_2 (sk + wk_1)) \text{ which may}$$

be expressed in roentgens by $R = 8.6D$ and wherein

$$f_1 = \frac{1}{\left(\frac{w}{L}\right)} \tan^{-1} \left\{ \frac{w}{L} / \left(\left(\frac{w}{L} \right)^2 + \left(\frac{\nu}{L} \right)^2 + \frac{1}{4} \right) \right\}$$

and

$$f_2 = \log \left\{ \left(\left(\frac{w}{L} \right)^2 - \left(\frac{\nu}{L} \right)^2 + \frac{1}{4} + \frac{w}{L} \right) / \left(\left(\frac{w}{L} \right)^2 - \left(\frac{\nu}{L} \right)^2 + \frac{1}{4} - \frac{w}{L} \right) \right\} / 2f_1 \left(\frac{w}{L} \right)$$

f_1 is plotted in Figure 1, in terms of $\frac{\nu}{L}$ and $\frac{w}{L}$. f_2 is given in Figure 2, also as a function of $\frac{\nu}{L}$ and $\frac{w}{L}$. If k_1 is small and

may be ignored for values of $w < 1 \text{ cm}$.

At distances from the needle greater than $2L$, f_1 approaches $1/(w^2 + \nu^2)$ and f_2 approaches $(w^2 + \nu^2)^{\frac{1}{2}}/w$, and these approximations may be used in calculations for such points.

binding of the electrons decreases, and we may assume that materials of lower atomic number are even less dependent on wall material ⁵

THE MEASUREMENT OF GAMMA RAYS IN ROENTGENS

The number of roentgens produced by radium cannot be measured in an ordinary parallel plate γ -ray ionization chamber because the range of many of the secondary beta rays greatly exceeds the dimensions of the chamber. It may be deduced from the formula of Klein and Nishina (8) and experimental data that nearly half of the beta rays have ranges distributed very gradually between 10 cm and over 300 centimeters. Hence the ionization current in a parallel plate chamber of the usual type increases rapidly as the distance of the plates from the γ -ray beam is increased to about 10 cm and then changes much more slowly. This is deceptive in creating an erroneous impression that the number of particles of range greater than 10 cm is relatively small. Mayneord and Roberts (9) point out that this effect is even more pronounced if the aperture defining the beam is close to the electrode system, on account of the angular distribution of the rays. Attempts to measure the number of roentgens with instruments of this type may be expected, for this reason, to give results which are too small (10).

In another method (11) an electroscope of very thin paper walls is used as the measuring device. The thin walls permit secondary beta rays from the surrounding air to enter the electroscope. The wall effect may be eliminated by varying the thickness of the wall and extrapolating to zero. The assumption, implicit in the method, that the intensity is uniform throughout the volume of air contributing the beta rays entering the chamber is only realized if the radium is at a distance from the electroscope which is great compared with the range of the beta rays.

⁵ Further experimental confirmation obtained in this laboratory will be published shortly.

Otherwise, too small a result may be expected.

A third method involves the use of small thimble chambers of material of low atomic weight (thus yielding negligibly few photo electrons). This method assumes that the wall contributes a number of beta rays equal to that which would be contributed by a large volume of air surrounding the test volume as required by the definition of the roentgen. It has been already pointed out in discussing the Imc-hr unit that the ionization due to beta rays from the walls is practically independent of this material for primary radiation consisting of the Kohlrausch Groups I, II, and III, provided that the chamber is small compared with the distance to the radium, and is of material of low atomic number. Therefore, we have adopted a value for the number of roentgens equivalent to one Imc-hr which is based on experimental determinations in which these experimental conditions have been fulfilled.

The following determinations appear to have satisfied these requirements. The values as given in the original papers applied to definitions of the Imc-hr which differed in general from the definition given in the previous section. The values given here have been adjusted to comply with the definition adopted in this paper.

Glasser and Mautz (12) 8.6 r/ Imc-hr
Mayneord and Roberts (9) 8.9 r/ Imc-hr
Sievert (13) 8.2 r/ Imc-hr

Other determinations have been made, e.g., by Reitz and L. H. Gray, which have not been included here because information on their experimental conditions is not available to us at the present time. However, they do not depart greatly from the above values.

The mean value of 8.6 roentgens per Imc-hr has been adopted ⁶. It is prac-

⁶ The Imc-hr unit used in this paper is about 7 per cent larger than the units used by Sievert and Mayneord. At the time this paper was read the author attempted to take this difference into account by modifying his own definition by the introduction of a numerical constant. Consequently a value of 8.0 for a ratio between the units was adopted on that oc-

- (5) BOHR, N Phil Mag, 1915, 30, 581
(6) RUTHERFORD CHADWICK, and ELLIS "Radio-
active Substances and Their Radiations" p 434 *et seq*
(7) KOHLRAUSCH and SCHRÖDINGER Wien Ber,
1914, 123, 1319
(8) KLEIN and NISHINA Ztschr f Physik, 1929, 93
(9) MAYNEORD and ROBERTS British Jour
Radiol, 1934, 7, 153
(10) FAILLA and HENSHAW, RADIOLOGY 1931, 17, 1
(11) EVE, A S Phil Mag, 1906 (6), 12, 189
(12) GLASSER and MAUTZ, RADIOLOGY, 1930, 15,
(13) SIEVERT Acta Radiologica, 1934, 15, 193
-

The average effective thickness of the needle wall is given by the formula

$$s = r_1 - \frac{Sr_2}{3\pi} - \frac{1}{8} \frac{r_2^2}{r_1} - \text{etc}$$

r_1 and r_2 are, respectively, the outer and inner radii of the wall. This was originally derived theoretically, but on rather questionable assumptions regarding scattering. The formula has been repeatedly tested by experiment, however, and found to be fairly accurate. Usually only the first two terms need be considered.

The absorption coefficient k must comply with the requirements set forth in the discussion of the Imc-hr unit. Therefore it is determined experimentally under the conditions specified in that discussion (relating to ionization chamber design, filtration, etc.). For these measurements a glass-walled radium standard was inserted in metal tubes similar to the needle wall. Correction was made for the glass k , a mean value for the three Kohlrausch Components, naturally changes slightly with the thickness of the material penetrated, but this is unimportant in practice and a suitable intermediate value is chosen.

k is smaller than the weighted mean of the values of the total absorption coefficients published by Kohlrausch and Sievert because it includes only part of the Compton absorption. This is due to the scattering in the needle wall. In materials of low atomic number the effective value of k for a needle wall is about 25 per cent of the total absorption. In heavier materials, the Compton absorption is less important and k increases to 80 per cent of the total absorption in the case of lead. The absorption in the wall of the ionization chamber is also affected by scattering and has been determined experimentally. The effective absorption coefficients for chamber walls of any material and for needle walls of the same material are found to be approximately equal.

The assumptions and approximations which have been made in deriving the formulæ do not produce large error except

within 5 mm of the needle wall and at points beyond the ends of the needle in directions from the center making angles of less than 15° with the axis. It was pointed out in Part I that this is not a serious limitation.

These claims have been tested by comparing values of the dose calculated by the present method with experimental values obtained by other writers with miniature ionization chambers, and by experimental tests of the variation of dosage at oblique angles carried out with larger ionization chambers.

SUMMARY

Part I—Formulæ and tables are given for the calculation of the dose at a point near a radium needle or tube. The preparation of dose charts for combinations of several needles is described.

Part II—Two units of gamma ray dose used in Part I are discussed, the milligram-hour per centimeter squared (Imc-hr) and the roentgen (r).

The derivation of the formulæ and tables used in Part I is given. The effective absorption coefficients employed were measured under certain experimental conditions which are specified. These differ greatly from total absorption coefficients which are not applicable in calculating dose.

The paper is an effort to simplify the calculation of the dose near radium needles by avoiding attempts to attain considerably greater accuracy than is required in radiological practice.

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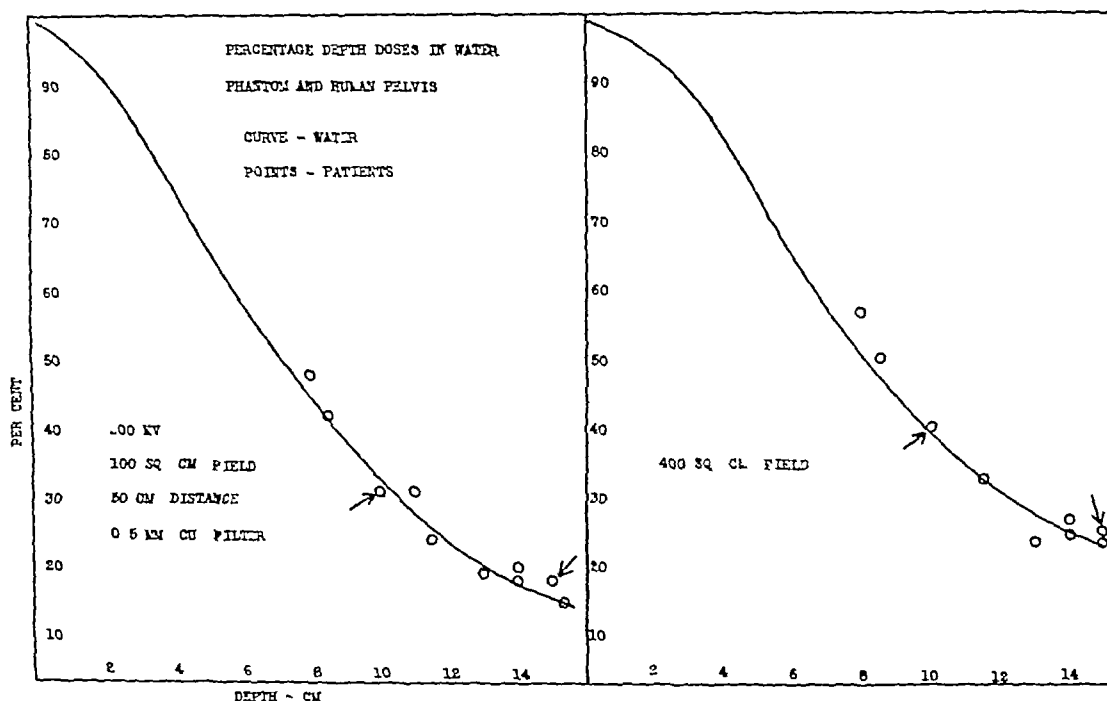


Fig 1 Depth doses in human pelvis compared with water phantom values. Curve water phantom points patients (ionization chamber in vagina). Points indicated by arrows were measured with beam incident on posterior surface of body; all others with beam incident on anterior surface.

sized the caution that must be exercised to guard against delivering excessive doses to normal tissues when several fields are used.

Failla and Quimby (11) have published depth dose charts for varied dosage factors, showing the distribution of radiation within and outside the geometric beam. They obtained the experimental data by measuring depth doses in a water phantom with an ionization chamber similar to that described by Friedrich. Their tables show how the amount of radiation delivered at a specified depth is influenced by the target-skin distance, size of port, and filtration.

Failla (12) has described an objective method for the accurate administration of roentgen rays to each individual patient. The position of the tumor is indicated upon a diagram representing the measured body contour at the level of the neoplasm. This is superimposed over charts illustrating the distribution of specified beams of roentgen radiation. A proper technic is then worked out to attain a maximum depth dose in the desired area, with a minimum exposure of normal tissues.

Weatherwax and co-workers (13, 14, and 15) have followed the method described by Failla to deliver a predetermined dose of radiation to each patient. In the treatment of carcinoma of the cervix, from 120 to 130 per cent of an erythema dose can be delivered to the mid-pelvis by the use of his four-field technic.

In a report on the treatment of cervical carcinoma, Schmitz (16) has published charts showing about 90 per cent of an erythema dose delivered to the cervix by roentgen irradiation through single ports on the anterior and posterior pelvic surfaces. Healy (17 and 18) has published anatomical cross-section charts in the sagittal and transverse planes of the pelvis, showing the percentage distribution of x-rays. Radiation delivered at a 50 cm target-skin distance through four ports 15 by 15 cm, supplied 120 per cent of the skin dose to the cervical region. From 100 to 120 per cent was obtained through a fairly wide portion of the pelvis. He also expressed the distribution of radiation within an average female pelvis in terms of threshold ery-

THE DISTRIBUTION OF ROENTGEN RADIATION WITHIN THE AVERAGE FEMALE PELVIS FOR DIFFERENT PHYSICAL FACTORS OF IRRADIATION¹

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IN the radiation treatment of carcinoma of the uterine cervix, a sufficient dose must be delivered not only to the primary lesion, but to the parametrial regions as well. Healy (1) has repeatedly stressed the fact that when radium is applied to the cervix alone it can be relied upon to control the disease directly in and about the primary lesion, but that it is incapable of destroying the tumor more than 3 or perhaps 4 cm from the cervical canal. Some other means must be employed in an attempt to deliver a lethal dose of radiation to the outlying tumor-bearing regions. External irradiation with roentgen rays is the method used most commonly for this purpose, and it is rapidly assuming a greater importance in the treatment of cervical cancer. In many clinics particular schemes for the administration of pelvic irradiation have been developed, to increase the dose delivered to the tumor, and to improve the distribution of radiation throughout the pelvis. Further advancement in the treatment of cervical cancer seems to be promised by the development of better methods for the use of x-rays, in order to deliver a sufficient dose to the inevitable parametrial metastases, rather than by changes in the methods of applying radium to the cervix.

The amount of radiation that may be delivered to a tumor is limited by the reaction of normal tissues, and is also influenced by the location of the newgrowth and the body contour at its level. Studies upon the effect of different physical factors of the roentgen-ray set-up on the amount and the distribution of the radiation delivered within the pelvis are important for determining a method best suited for the treatment of cervical cancer.

The earliest detailed work upon the distribution of roentgen radiation within a medium was done by Kroenig and Friedrich (2). Measurements were made with an ionization chamber placed at various depths in a water phantom. The effects of different physical factors on the depth dose were studied. Shortly after the appearance of this comprehensive work, Des-sauer and co-workers (3, 4, and 5) published an extensive study showing the distribution of radiation in a water phantom, for beams of radiation with various fields, voltages, and filtrations, as determined by photographic methods. They also prepared diagrams to illustrate the total dose obtained from radiation delivered through several portals into a given volume. Because of the short target-phantom distance used (25 to 30 cm), the charts have little practical application at the present time.

Holfelder (6 and 7) prepared colored depth dose charts made of transparent material to represent the distribution of radiation in a beam of x-rays, shaded according to the relative intensities at different depths. He illustrated visually that a larger depth dose could be delivered at a given point within the body by increasing the number of ports, with all the beams directed toward the same region. Jungling (8) and Bachem (9) have made similar studies.

In this country, Pfahler (10) made use of Holfelder's colored depth dose charts in the treatment of carcinoma of the cervix. He considered it desirable to deliver 120 per cent of an erythema dose to the tumor area by roentgen radiation. In the ordinary patient he was unable to obtain this dose in the mid-pelvis through single anterior and posterior fields, but found that it could usually be accomplished by increasing the number of ports. He empha-

¹ Presented before the Radiological Society of North America at the Twentieth Annual Meeting at Memphis Tenn Dec 3-7, 1934

varying distances to one side. A comparison of data thus obtained and of corresponding water phantom values is shown in Figure 2, for a depth of 8 cm, for a target-skin distance of 70 cm, and fields of 100 and 400 square centimeters. In each case the solid line represents the values of percentage depth dose in the water phantom for various distances from the axis. The crosses indicate individual observations on a single patient. The precision of measurement is not high, it is, however, evident that the water phantom charts represent satisfactorily the dose delivered within the pelvis.

It is evident from the above that numerous studies have been made upon the distribution of x-rays within the pelvis. Various authors have shown that the percentage depth dose can be increased by the use of higher voltages, heavier filters, longer distances, larger ports, or combinations of these factors. However, no correlated study has been published on the influence of varying specific factors on the distribution of radiation throughout the pelvis. The charts that have been presented to illustrate the advantages of different methods have dealt mainly with individual patients, and particular schemes of irradiation. It is impossible to obtain data for comparative values from a review of the literature, because of discrepancies in percentage values reported by various authors, even when they apparently used identical methods of irradiation and measurement. These variations are largely due to the different sizes of pelvises considered in the individual cases.

For a practical comparison of methods of pelvic irradiation it is necessary to establish a certain body contour as a standard size, and then study the variations of distribution of radiation within this as various factors are changed, one at a time. The size of the pelvis to be used was determined from measurements made upon 25 women taken at random from the gynecological out-patient department. Anteroposterior diameters measured with the patient lying on her back in the usual position for treat-

ment were found to vary from 15 to 31 centimeters. Lateral diameters taken in the same position ranged from 28 to 43 cm, and with the patient lying on her side varied from 27 to 38 centimeters. These measurements were made in a plane passing through the head of the femur and the upper border of the symphysis pubis. This level was chosen to represent approximately that of the cervix. The average anteroposterior and lateral diameters were 23 cm and 35 cm, respectively. A diagram of the body contour at the level of the cervix was drawn with these dimensions.

Having adopted a pelvis of this size, the volume throughout which the distribution of radiation is to be studied is standardized. It is equally necessary to choose skin fields of a size suitable for the roentgen treatment of cervical cancer. Also, for comparing different methods of treatment it is desirable to keep the total area of irradiated skin constant on each of the pelvic surfaces, regardless of the number of fields used. That is, the total area of two small fields on the anterior or posterior pelvic surfaces should be the same as for one large port on the same region. If the same area, or the same volume, is irradiated in two given schemes, the systemic effect of the irradiation and the effect on normal structures may be considered the same, and a comparison made strictly on the basis of the radiation delivered to the involved region.

In general, the irradiated area should include the lower pelvic lymphatics as well as the promontory of the sacrum. Metastases from cervical cancer may go downward along the vaginal tube, but more frequently involve the lymph nodes at the pelvic brim, where the ureters may become obstructed. If there is no evidence of disease about the vaginal outlet, the direct beam should not be permitted to strike the external genitalia, because of the severe reactions which may be produced on the vulva. In order to avoid unnecessary exposure of sensitive tissues, and to include all of the tumor-bearing regions, the skin fields on most patients should extend from the middle of the symphysis pubis to the

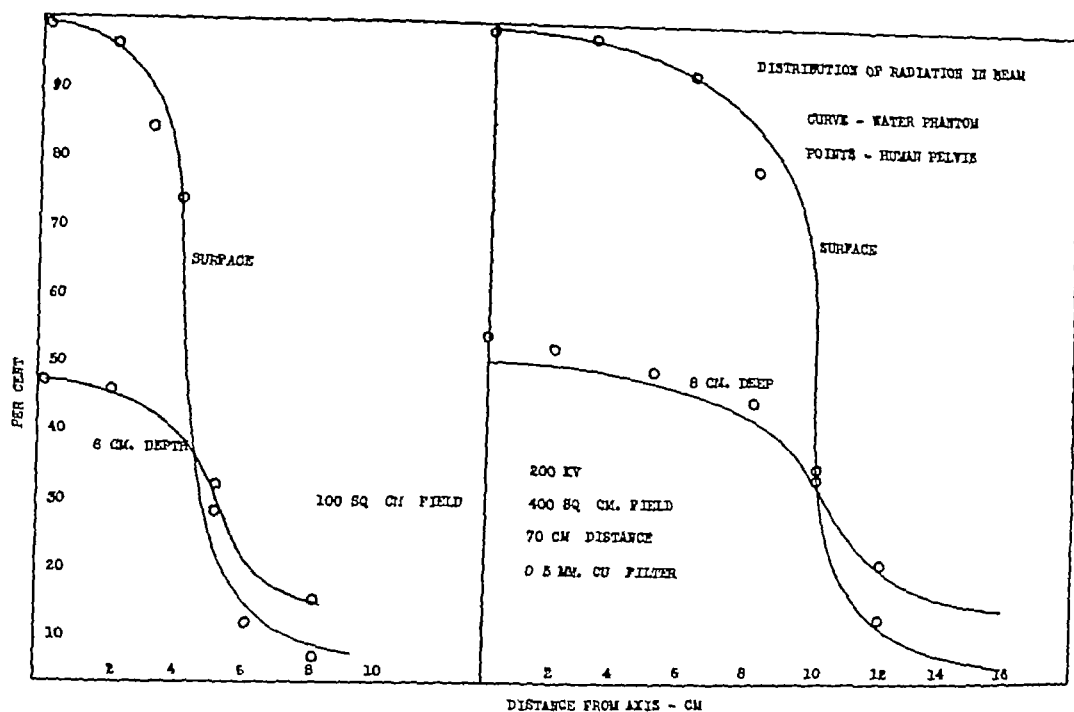


Fig 2 Comparison of distribution of radiation throughout the beam in water phantom and in human pelvis Curve, water phantom, points, patients

thema doses from the combination of radium and roentgen-ray treatments

All depth dose charts mentioned thus far have been obtained by measurements made in a water phantom. Quimby, Copeland, and Woods (19) compared the radiation at various depths in a human cadaver and in a water phantom, and found that, for points within the pelvis, the two were in close agreement. It was felt that the measurements in the cadaver should be supplemented by some made on living persons, and the present authors undertook a series of such measurements. The method and apparatus used are described in the paper just referred to, part of the results obtained were included therein. For each patient, the radiation was measured with the chamber on the surface of the body and in the vagina, the beam being centered over the chamber in each case. In all patients, measurements were made with beams incident on the anterior surface of the body, in a few, posterior irradiations were also measured. Fields of 100 sq cm and 400 sq cm were used, with x-rays at 200 K V peak, filtered by 0.5 mm Cu and

2.5 mm Al, and a target-skin distance of 50 centimeters. Obviously each patient could give a value for only one depth, that of the cervix. The use of patients of different sizes made possible the collection of values for depths ranging from 8 to 17 centimeters. The results obtained are shown in Figure 1, for fields of 100 and 400 square centimeters. The solid line in each case represents the water phantom values. The points indicate data obtained from individual patients, those marked with an arrow being measurements made with the beam incident posteriorly, all others were for anterior irradiations. It is evident from these curves that the water phantom data adequately represent the percentage depth doses delivered in the female pelvis for points at the center of the beam.

In the majority of pelvic irradiations, the beam is not centered over the cervix, but two anterior ports are used. In order to test the applicability of isodose charts from water phantom measurements, for points other than those on the axis of the beam, the chamber was left in place in the vagina while the x-ray tube was moved

external irradiation which will minimize the quantity reaching these normal, sensitive structures, and yet deliver a suitable depth dose to regions that may harbor disease, would be the most desirable

One factor which will contribute to such a distribution is the directing of the roentgen-ray beams toward the parametria rather than toward the cervix. Such an arrangement has been used throughout the work reported here, whenever two fields were used on the anterior and posterior surfaces. These fields were spaced 2 cm apart in the mid-line, to prevent overlapping of the radiation on the skin, and also to minimize the overlapping of the direct beams in the bladder and rectal regions. If the beams were tilted toward the mid-line so as to cross-fire on the cervix, a greater depth dose could be delivered to the primary lesion, but at the expense of the amount of radiation reaching the lateral portions of the parametria. Also, tilting the beams toward the mid-line increases the dose delivered to the bladder and rectum. Lateral beams add very little to the dose delivered to the cervix, bladder, or rectum. These were directed straight toward the mid-point of the anteroposterior diameter so as to deliver the maximum amount to the parametrium.

It should be noted that the data presented here pertain only to external irradiation. No consideration has been given to the uterine application of radium. The object of this work is to ascertain the most desirable method for the administration of roentgen radiation. In the publications of Healy and Schmitz already referred to are contained data upon the intravaginal and uterine applications of radium, which may be used in combination with any of the charts presented here.

SINGLE FIELDS 15×20 CM ON THE ANTERIOR AND POSTERIOR PELVIC SURFACES

Due to the broad area on the anterior and posterior surfaces of the pelvis, single large fields have often been used in these regions for roentgen treatment of pelvic

neoplasms. If large fields are employed, the beam of radiation can include the parametrial regions as well as the cervix. By the use of a few large fields, the pelvic cycle can be completed in a shorter time. An argument sometimes advanced for the use of large fields is the increased depth dose obtained with increased area. The corresponding argument for small fields is that the skin reaction in this case is less than with a larger area. These statements apply only to the use of single isolated fields; they would have to be considerably modified for the type of irradiation represented by the pelvic cycle. When the total irradiated area is the same, it makes little difference whether it is all exposed at once or at two separate sittings. Therefore the comparison of the two- and four-field techniques on the basis of the distribution of radiation, as shown, does not have to be modified by these considerations.

The percentage distribution of radiation within the pelvis, for x-rays delivered through single fields measuring 15×20 cm on the anterior and posterior pelvic surfaces is shown in Figure 3, for target-skin distances of 50 and 70 centimeters. At 50 cm this two-field method delivers a depth dose of from 50 to 60 per cent at the mid-pelvis, or cervical region. The transverse diameter of the region receiving this dose, at the depth mentioned, is 11.5 centimeters. Both the bladder and rectum receive a greater dose (about 60 to 80 per cent). Throughout the parametria the minimum dose, distributed over a volume 17.5 cm wide, is 40 per cent.

If the same dosage factors are used, except that the target-skin distance is increased to 70 cm, the percentage depth dose reaching the cervix is increased about 10 per cent. There is a corresponding rise in the dose delivered to the bladder and rectum. Throughout the parametria a minimum dose of 40 per cent is distributed over a volume 19 cm wide.

In both of these methods of treatment the depth dose delivered to the cervix is considerably greater than that throughout most of the parametria. Also, the amount

iliac crests. Fields with a longitudinal diameter of 15 cm will usually cover these bony landmarks. The transverse diameter of the irradiated skin area on the anterior and posterior pelvic surfaces should be about 20 centimeters. Therefore, a large field measuring 15×20 cm, or two smaller fields, measuring 15×10 cm on each of these surfaces, seem to be desirable for the treatment of cervical cancer.

If lateral fields are to be employed, the same bony landmarks can be used that served to mark off the anterior and posterior areas. That is, the skin field can be placed so that it extends 15 cm below the crest of the ilium. In most patients the lateral surface of the pelvis is sufficiently broad to permit the use of an area 10 cm wide.

Depth dose charts were prepared according to the method described by Failla and Qumby (11) to illustrate the distribution within and outside the geometrical beam, for fields measuring 15×20 cm, and 15×10 centimeters. A mechanically rectified x-ray machine was used, with a filter of 0.5 mm Cu and 2.5 mm Al. Data were obtained for target-phantom distances of 50 and 70 centimeters.

With the standard size pelvis, the distribution of radiation was studied for a number of combinations of fields and distances, such as might be considered practical in the average radiological department. Diagrams illustrating the distribution were made by placing the proper depth dose chart in the correct position for treatment, under the outline of the pelvis drawn on transparent paper. The contribution from each beam was noted at various points within the pelvis, and the sum of all these was calculated for each point. Lines drawn through points receiving the same total radiation (so-called "isodose lines") divide the pelvis into regions receiving specified doses. Such lines were drawn for every 10 per cent variation in total depth dose.

The dose delivered on the skin by each beam was taken as 100 per cent. This does not indicate any definite quantity of

radiation. Since the depth dose is expressed in terms of percentage of the quantity of radiation delivered at the surface of a single field, the per cent dose recorded in the diagrams represents the summation of the radiation reaching any given point after the sequence of treatments has been completed. If an erythema dose given to each of four ports delivers a depth dose of 80 per cent to the cervix, that region has received 0.8 of a skin erythema dose.

As stated above, variations of 10 per cent or more have been shown on the diagrams. In some instances, when all factors remained the same except that a greater target-skin distance was used, the depth dose delivered to a certain point shows no change on the diagrams, because the actual increase was less than 10 per cent. The values given in the diagrams have no relation to results previously published by other authors, nor do they express the exact percentage distribution of radiation within any particular individual treated with the same dosage factors. They represent the distribution within a pelvis measuring 23 cm in the anteroposterior diameter, and 35 cm in the transverse diameter. Patients of smaller dimensions will receive a greater percentage depth dose, and those of larger sizes will receive less. Since the size of the pelvis is kept the same throughout, the diagrams afford a comparison of the relative merits of the different methods of treatment.

Such a comparison should be based upon two factors: the amount of radiation reaching the tumor area, and the quantity delivered to normal tissues. In roentgen irradiation of the pelvis, the dose obtained at the cervix, or mid-pelvis, is usually considered of greatest importance. It should be borne in mind, however, that the outlying parametrial regions demand even greater consideration, because, in general, radium can be depended upon to control the primary lesion. In many cases the bladder and rectal regions are not infiltrated by the disease, and must be protected from excessive doses. A method of

the bladder and rectal regions, would be a definite advantage

TWO FIELDS OF 15×10 CM EACH, ON THE ANTERIOR AND POSTERIOR PELVIC SURFACES

The percentage distribution within the pelvis, of radiation delivered through two fields measuring 15 by 10 cm each, on both the anterior and posterior pelvic surfaces, is shown in Figure 4, for target-skin distances of 50 and 70 centimeters

At a 50 cm distance this method delivers a depth dose of from 60 to 70 per cent to the cervical region. Both the bladder and rectum receive the same dose as is delivered to the primary lesion. The total amount of radiation reaching the mid-pelvis is a slightly greater percentage of the skin dose than is obtained through large single fields on the same pelvic surfaces, when an identical target-skin distance is used. The distribution throughout the parametria is somewhat better with the four-field method. A minimum dose of 40 per cent is distributed over a wider volume (21 instead of 17.5 centimeters)

If four skin ports are used with a target-skin distance of 70 cm, a depth dose of from 60 to 70 per cent is delivered to the cervix, bladder, and rectum. Throughout the parametria the percentage depth dose distribution is similar to that obtained from a two-field method with the same target-skin distance, except that a minimum dose of 40 per cent is distributed over a volume 22 cm wide. The dose recorded on the diagram for the cervix does not show an increase over that obtained in the same region by the four-field method at 50 cm distance, or by large single fields at 70 cm, because the increase is less than 10 per cent. However, the diagram does illustrate that the lateral borders of the volume receiving from 60 to 70 per cent are pushed further out into the adjacent parametria.

The greatest advantage of the four-field method is the protection it gives to the bladder and rectum. These regions are spared doses in excess of the amount of

radiation delivered to the cervix, when the beams are oriented as described above

LATERAL FIELDS OF 15×10 CM AND LARGE SINGLE FIELDS ON THE ANTERIOR AND POSTERIOR PELVIC SURFACES

If lateral beams are added to any anterior and posterior port arrangement, the depth dose delivered to the parametrial regions will be increased considerably. On the other hand, because of the depth of the cervix below the lateral skin surface, the increase in the dose reaching the primary lesion will be small. Such a distribution within the pelvis may be desirable, because the primary lesion can be treated by radium applied to the cervix. The effect of adding lateral beams to the port arrangements already discussed will now be considered. In each instance the lateral fields measured 15×10 cm, with the same target-skin distance as was used for the anterior and posterior fields. The percentage distribution for radiation within the pelvis, for x-rays delivered through lateral fields and large single fields on the anterior and posterior pelvic surfaces, is shown in Figure 5, for target-skin distances of 50 and 70 centimeters.

At a 50 cm target-skin distance this method delivers a depth dose of 70 per cent to the cervix, and a surrounding region 8 cm wide in the transverse diameter. Lateral to this region the total depth dose is increased as the skin surface is approached, so that the bulk of the parametrium receives from 70 to 90 per cent. The dose delivered to the bladder and rectal regions is also from 70 to 90 per cent each.

If the same port arrangement is used for a target-skin distance of 70 cm, the dose delivered to the cervix and surrounding tissues is increased to 80 per cent. The bulk of the parametria receives from 80 per cent to about 95 per cent, which is an increase over the dose delivered to the same regions by the preceding method. A somewhat greater dose is delivered to the bladder and rectum than to the cervix,

of radiation reaching the bladder and so that a greater percentage of the radiation rectum is from 20 to 30 per cent greater tion would be delivered to the parametria,

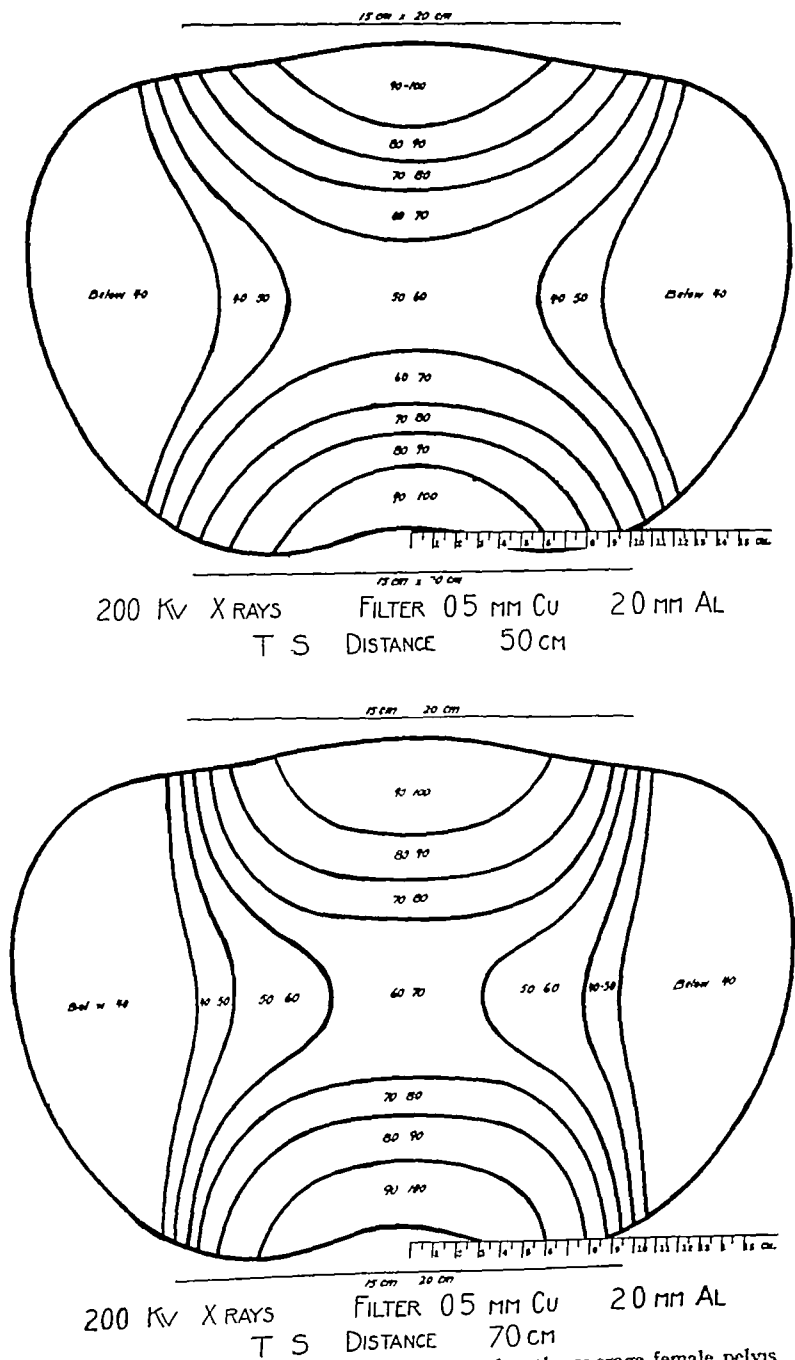


Fig 3 Distribution of roentgen radiation within the average female pelvis for large single fields measuring 15 X 20 cm on the anterior and posterior surfaces

than the dose delivered to the primary lesion To alter the method of treatment and to prevent such a wide discrepancy between the dose reaching the cervix and

canal, and probably be within the volume per cent greater than the dose delivered that can be controlled by radium Lateral to the cervix

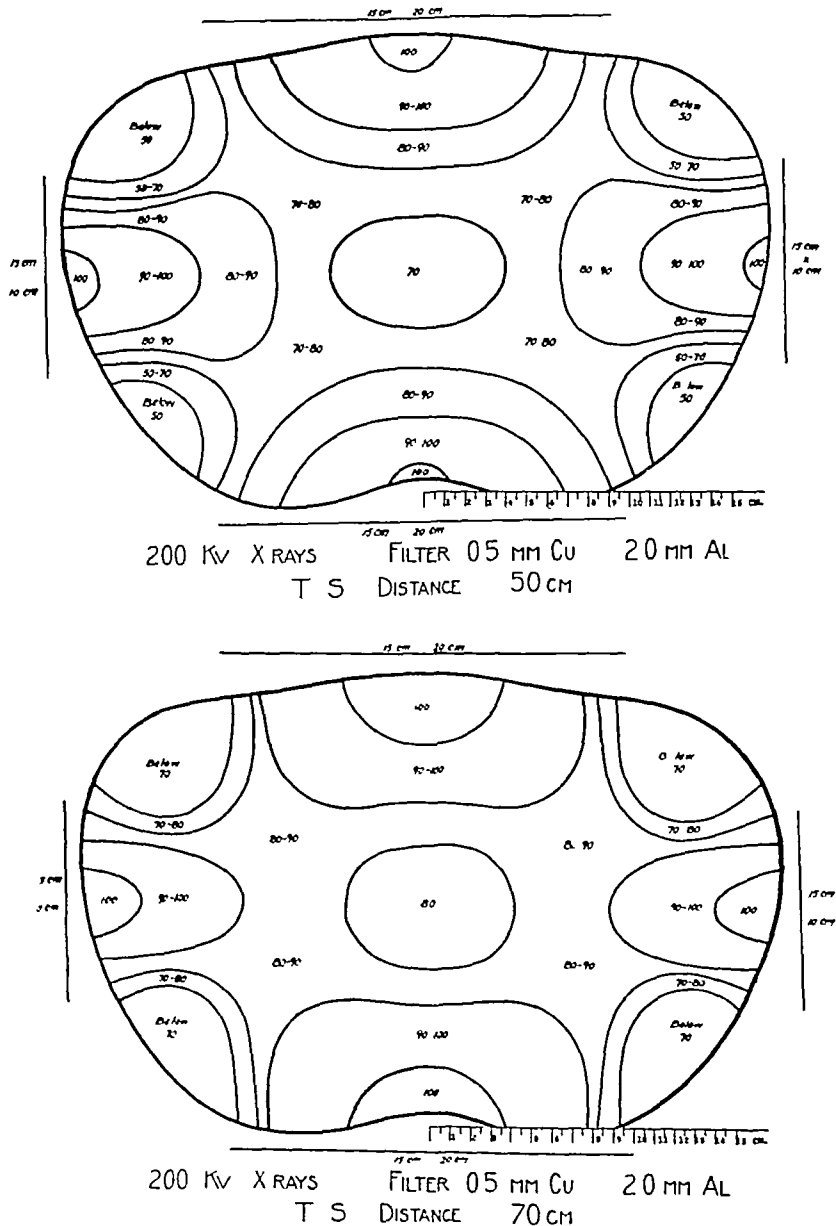


Fig 5 Distribution of roentgen radiation within the average female pelvis for the addition of lateral beams to single large anterior and posterior portals

to this dosage area, at distances beyond the zone of effect by radium applied to the cervix, the depth dose is considerably greater. However, the dose delivered to the bladder and rectum is from 18 to 27

LATERAL FIELDS OF 15×10 CM AND TWO FIELDS ON BOTH THE ANTERIOR AND POSTERIOR PELVIC SURFACES

Diagrams illustrating the distribution of radiation within the pelvis for the addition

cent The distribution throughout regions lateral to the cervical canal is not very different from that obtained in the same

The doses delivered to various points along a line drawn in the transverse diameter through the middle of the pelvis would

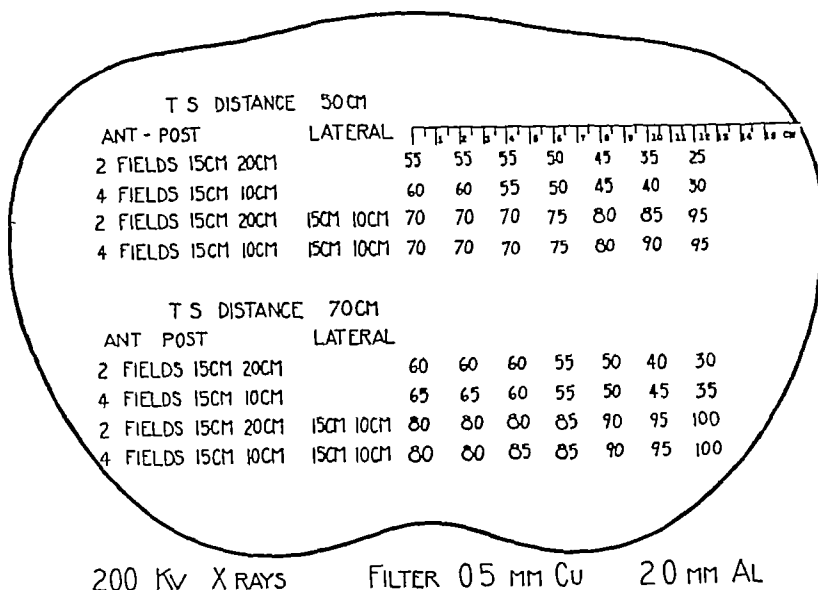


Fig 7 Doses delivered to the mid pelvis and to points 2 cm apart along a transverse line drawn directly lateral to the cervix for each of the port arrangements and target skin distances considered

method employing large fields instead of double ones on the anterior and posterior surfaces. However, as has been noted for all double anterior and posterior port arrangements, the bladder and rectum receive no more radiation than the cervix does, and probably a little less.

DISCUSSION

A study of the various charts illustrating the percentage distribution of radiation in the pelvis for different methods of external irradiation, reveals that certain procedures have definite advantages over others. The criteria by which the efficiency of any method may be judged in this manner are based upon physical expressions of the amount of radiation reaching any given point. There are two factors to be considered, first, the dose delivered to the mid-pelvis and to the parametrial regions, which represent the tumor area, and second, the ratio of the dose reaching the bladder and rectal regions to that obtained at the cervix.

indicate the minimum amounts of radiation delivered to the tumor-bearing region in patients with carcinoma of the cervix. The doses delivered to the middle of the pelvis, and for every 2 cm lateral to this point for a distance of 12 cm, are shown within a diagram of the pelvis in Figure 7. Values are presented for all of the methods which have been discussed, and were taken from the original diagrams made in preparation of those given in this paper. The values represent the summation of radiation reaching specific points from all contributing beams. They follow closely, but not exactly, the percentage areas illustrating the distribution of radiation for specified dosage factors. Variations are due to the fact that the table shows differences of more than 5 per cent, whereas the zones on the diagrams are made by 10 per cent steps.

The distribution of radiation throughout the pelvis for the various sets of ports has already been discussed in detail. It has been shown that the use of large single fields on the anterior and posterior pelvic

of lateral beams to the four-field set-ups already discussed, for target-skin distances of 50 and 70 cm are shown in Figure 6

vical canal is not very different from that obtained from lateral beams and large single anterior and posterior fields at a

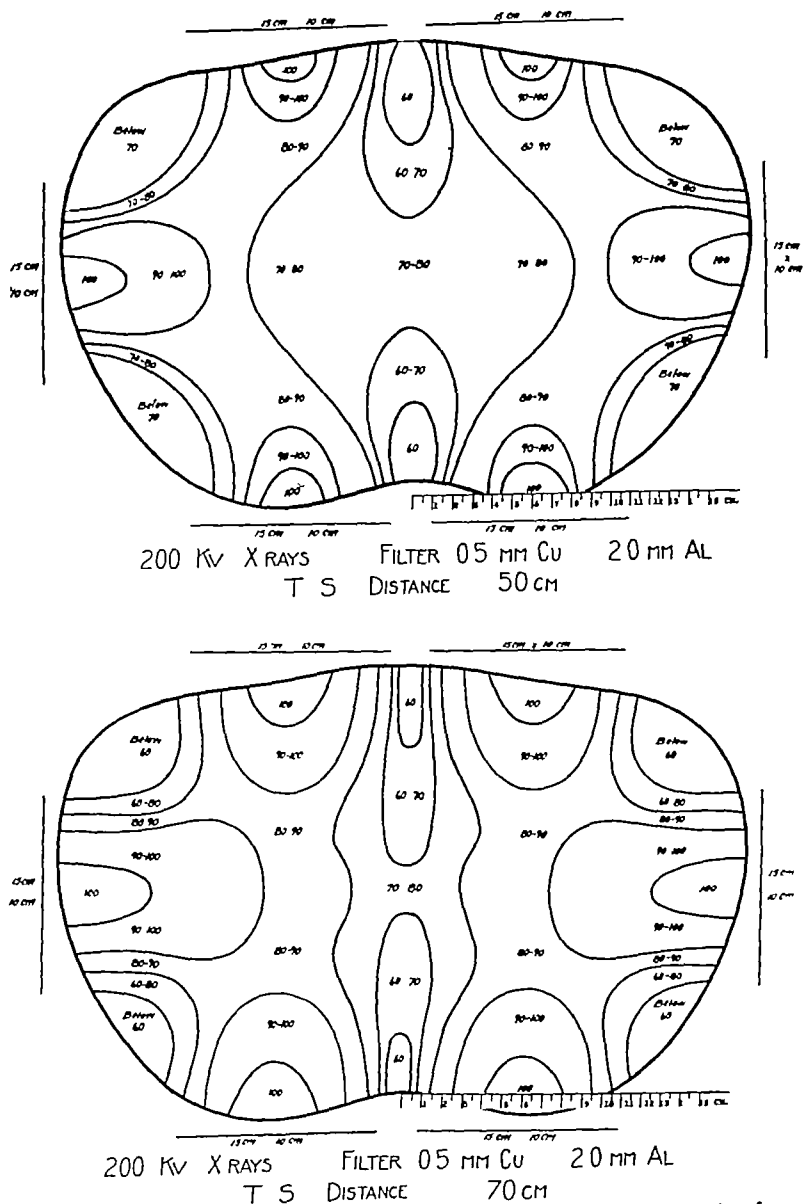


Fig 6 Distribution of roentgen radiation within the average female pelvis for the addition of lateral beams to two portals on both the anterior and posterior pelvic surfaces

If a 50 cm target-skin distance is used for this six-field arrangement, the cervix receives a depth dose of from 70 to 80 per cent. The transverse diameter of this dosage area is 16 cm wide. The distribution throughout regions lateral to the cer-

50 cm target-skin distance. However, in the six-field technique, both the bladder and rectum receive no more radiation, and probably less, than the cervix does.

If a 70 cm target-skin distance is used, the cervix receives about 70 to 80 per

terial in order to locate the position of the cervix. An exposure was made with the patient lying on her back, and the tube centered in the mid-line, with a target-skin distance of 70 cm, over a point halfway between the middle of the symphysis pubis and the iliac crests. The tube was then centered over the left pelvis in the usual manner for treatment. Without disturbing either the patient or the cassette containing the film, a lead shield with an open port measuring 15 by 10 cm was placed over the abdomen so as to confine the beam to the left anterior pelvis in the correct position for treatment. A second exposure (150 per cent of the first) was then made. The same process was repeated on the right side. The positions of the two fields can be clearly seen on the radiograph. From the contrast material in the vaginal vault it can be seen that the cervix as well as the promontory of the sacrum is included in the direct beams. There is slight overlapping of the two beams on the film, they probably come together at about the depth of the cervix. As has been stated before, heavy roentgen irradiation of the cervix is not felt to be absolutely necessary, since radium can be used to deliver sufficient radiation to this region. It seems more logical to separate the fields in the mid-line in order to protect the bladder and rectum from excessive doses. A separation of about 2 cm is preferable to greater or less spacing. If the fields are brought closer together, the dose delivered to the bladder and rectum is increased, and there is danger of overlapping the fields on the skin. If there is a separation of much more than 2 cm, the dose delivered to the mid-pelvis is apt to be decreased so that too little radiation will be delivered to the tissues located at a distance beyond the radius of action of radium applied to the cervix.

No statement has been made about the dose delivered to the skin, nor is it necessary to consider the rate at which radiation is administered in a study of its distribution throughout the pelvis. It is only necessary to deliver equal doses to all of

the fields in order to obtain the percentage depth doses that have been given for certain specified conditions. As far as the ratio between surface and depth dose is concerned, it makes no difference whether the radiation is administered at a single sitting, or in several exposures. If a divided dose method is used, a greater total amount of radiation may be delivered to the skin, and the total depth dose increased in the same ratio.

As has been stated, all the data given thus far are for x-rays at 200 K V filtered by 0.5 mm Cu and 2.5 mm Al. Since in many clinics filters of 2 mm Cu are in current use, it is of interest to know what increase in depth dose would be attained for the various schemes of irradiation, with this increase in filter. Quimby and Marinelli (20) have shown that, with a field of 100 sq cm, increasing the filter from 0.55 mm Cu to 2.16 mm Cu increases the dose on the axis of the beam at 5 cm depth by 3 per cent, at 10 cm depth by 6 per cent, and at 15 cm depth by 12 per cent. Failla and Quimby (11) have shown that the effect of change in filter is independent of the field and of the target-skin distance, therefore, the values just given apply to the irradiation systems discussed in the present paper. It is evident that the increase in depth dose throughout the pelvis, for the increase in filter under discussion, would be about 6 per cent. In order to obtain this slight increase in depth dose it is necessary to use an irradiation period three times as long, to compensate for the absorption in the filter. If the compound filter of Thoræus is used (to equal 2 mm Cu), the irradiation time is twice as long as for 0.5 mm Cu. An increase of the target-skin distance from 50 to 70 cm produces twice as much improvement in depth dose as the increase in filter from 0.5 to 2.0 mm Cu, and requires only half as much increase in time. From the economic point of view it is evident that increases in filtration are undesirable. The question of an improvement in results with the change in quality of radiation produced by the increase in



Fig 8 Distribution of radiation within the average female pelvis for two skin portals measuring 15×10 cm each on the anterior pelvic surface.

surfaces delivers a greater dose to the bladder and rectal regions than to the cervix. It has also been shown that double small fields, half the size of the larger ones, can be used to irradiate an equal area of skin, to deliver the same depth dose, and to spare the bladder and rectum from doses in excess of that reaching the cervix. The addition of lateral fields to any port arrangement increases the depth dose delivered at all points within the pelvis. The greatest improvement is in the parametrial regions, which, at a distance of 6 cm from the mid-line, receive more radiation than the cervix. In view of these facts it seems that a six-port arrangement (two anterior, two posterior, and one on each lateral surface), with a 70

cm target-skin distance, is the best of the methods here investigated for delivering roentgen radiation to patients with cervical cancer.

No set rules can be established for the treatment of all patients. However, in most cases it is possible to irradiate all of the tumor-bearing region by the six-field technique just described. If the fields are 15 cm long, they will usually reach from the middle of the symphysis pubis to the iliac crests, which can be used as bony landmarks for outlining the portals around the pelvis. A radiograph is shown in Figure 8 to illustrate the distribution of radiation for the two anterior fields. For the preparation of this film, the vaginal vault was first marked by an opaque contrast ma-

beams with each of the above plans. Each of the four different port arrangements was studied for target-skin distances of 50 and 70 centimeters. Large single fields on the anterior and posterior pelvic surfaces measured 15 cm in the longitudinal diameter, and 20 cm in the transverse. If two fields were used on these surfaces, they measured 15×10 centimeters. By this means the total irradiated area on these surfaces was kept the same. In those instances in which lateral beams were added, these fields were also 15×10 centimeters.

The percentage depth dose may be increased more economically by the use of greater target-skin distances than by the use of heavier filters.

A six-field technic (two anterior, two posterior, and one on each lateral surface), oriented in the manner described, with a target-skin distance of 70 cm, is the most desirable of the methods herein investigated for the treatment of cervical cancer.

In most cases the lower border of the fields should not extend below the middle of the symphysis pubis. The direct beam will then include the cervix and upper vagina, but will not strike the external genitalia. If the longitudinal diameter of the fields is 15 cm, the promontory of the sacrum will be included, and the skin portals will usually extend to the crest of the ilium. These two fixed levels (middle of the symphysis pubis and iliac crests) are advocated as bony landmarks for the marking out of pelvic fields.

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filter is as yet far from being satisfactorily answered

With regard to the economic aspect, certain other considerations may be set forth. Increasing the target-skin distance from 50 to 70 cm means that the time of irradiation must be doubled to deliver the same skin dose. Six fields require three times the treatment time of two, and once and a half the time of four. In some clinics, where pressure of work is so great that any improvement in technic must be weighed against the increased time required, an analysis should be made of the relative merits of various schemes. It is evident that of the schemes here considered the six-field technic with a 70 cm target-skin distance is the most desirable. However, six fields at 50 cm can be treated in half the time, and four at 70 cm in two-thirds the time. Six fields at 50 cm deliver a dose only slightly less along the mid-line than six at 70 cm, and the distribution throughout the parametria is almost as good. Hence by this means the time may be cut in two without severe loss of dosage. On the other hand, four fields at 70 cm give smaller doses both in the mid-line and the parametria than six fields at 50 cm, although the treatment time is longer. In the same way any proposed technic may be compared with one chosen as standard, in order to determine its relative advantages and disadvantages.

The large fields were, of course, directed straight into the pelvis. When two fields were used on the anterior and the posterior surfaces, they were also directed straight into the pelvis, and separated in the mid-line by a distance of 2 centimeters. This was done in order to direct the radiation toward the underlying parametria, and to protect the bladder and rectal regions from doses in excess of the amount delivered to the cervix. For these reasons the use of two fields on both the anterior and the posterior pelvic surfaces is more advantageous than large single ones, which deliver a greater amount of radiation to the bladder and rectum than to the cervix. However, the distribution of radiation

throughout the tumor-bearing region is not very different for the two methods when the total irradiated area and the target-skin distance are kept the same.

Lateral beams add slightly more to the cervix than to the bladder and rectal doses. The most marked benefit from such fields is obtained in the parametrial regions (beyond the radius of effect from radium applied to the cervix), which in this case receive a greater dose than the cervix itself. Therefore, the combination of lateral beams with two fields on both the anterior and posterior pelvic surfaces affords the best distribution of radiation throughout the pelvis. By this means the bladder and rectum receive no more, and probably less, radiation than the cervix does. Radium can be applied to the cervix, so that the primary lesion receives a greater dose than either the rectum or bladder. The greatest amount of roentgen radiation is delivered to the parametrial regions, which cannot be adequately treated by cervical application of radium.

SUMMARY AND CONCLUSIONS

The distribution of radiation throughout a pelvis of standard dimensions (determined from measurements upon 25 patients) has been studied for a variety of methods for the administration of roentgen radiation. By this means a comparison can be made of the relative effectiveness of the different methods studied. Patients of smaller size than the standard pelvis would receive a greater percentage depth dose than has been recorded on the diagrams, larger patients a smaller amount of radiation in the tumor-bearing region. The diagrams that have been presented serve to indicate which method is best suited for the treatment of carcinoma of the uterine cervix.

The different port arrangements which have been studied were as follows: large single fields on the anterior and the posterior pelvic surface, two fields on the anterior surface, with two on the posterior surface, and the combination of lateral

beams with each of the above plans. Each of the four different port arrangements was studied for target-skin distances of 50 and 70 centimeters. Large single fields on the anterior and posterior pelvic surfaces measured 15 cm in the longitudinal diameter, and 20 cm in the transverse. If two fields were used on these surfaces, they measured 15×10 centimeters. By this means the total irradiated area on these surfaces was kept the same. In those instances in which lateral beams were added, these fields were also 15×10 centimeters.

The percentage depth dose may be increased more economically by the use of greater target-skin distances than by the use of heavier filters.

A six-field technic (two anterior, two posterior, and one on each lateral surface), oriented in the manner described, with a target-skin distance of 70 cm, is the most desirable of the methods herein investigated for the treatment of cervical cancer.

In most cases the lower border of the fields should not extend below the middle of the symphysis pubis. The direct beam will then include the cervix and upper vagina, but will not strike the external genitalia. If the longitudinal diameter of the fields is 15 cm, the promontory of the sacrum will be included, and the skin portals will usually extend to the crest of the ilium. These two fixed levels (middle of the symphysis pubis and iliac crests) are advocated as bony landmarks for the marking out of pelvic fields.

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THE RELATION OF AIR IONIZATION TO RADIATION ABSORBED AND THE EFFECT ON BODY TISSUES¹

By WILLIAM H MEYER, M D, *New York City*

Professor of Radiology, New York Post-graduate Medical School and Hospital of Columbia University

AS Dr Taylor has announced, this is a volunteer contribution to replace some of the absentees on the program. The detail of my subject matter is not at hand but in New York. The presentation is, therefore, extemporaneous, with a further apology for the hastily prepared slide of the chart. This difficulty will be remedied in the final publication.

Physicists have done much to give us standards of quantitative and qualitative measurements. There remains considerable doubt and controversy, with uncertainty in the linking of the physical dose measurement with observed skin reaction and biologic effect. Until some definite relation between physical quantitative and qualitative radiation measurements and skin and biological reaction is established, present-day standardization remains but an arbitrary estimate of radiant energy or tube output.

For more than twenty years we have continued our study of these problems, and in an article published as early as 1920 (1) I recorded my impressions on the relation of skin and human tissue reaction to absorption as determined by photographic measurements.

With the improvement in ionometric quantitative dosimetry, this method became a supplement to and substitute for the photographic, pastille, and other dosage measurements. The results of some of this work were published in 1926 (2 and 3) and again in 1927 (4) and 1928 (5), with further follow-up in 1933 (6).

The possibility of an index constant to biologic reaction derived from a comparative study of the half value layer in

phantom was suggested in a publication by Meyer and Glasser in 1926 (3).

I am taking the liberty of appearing before you again in this matter since, in addition to a careful review of our work, we have extended our studies to include increased voltage and filtration and are still seeking the truth with regard to the measurement of r by ionization in its relation to skin and tissue reaction.

Notwithstanding some expressed adverse opinion, we still believe that we are correct in the assumption that the number of roentgens as measured by ionization will vary considerably with respect to a given skin or mass biologic reaction, this depending to a great extent upon variations in ray quality, resulting from changes in voltage and filtration.

From the physical aspect of the problem, the advertisements of manufacturers—that their particular ionometers are independent of the wave length—but add to the confusion, since every physicist well knows that no thumb wall type of ionization chamber to-day can be considered as independent of ray quality.

F C Wood, in a recent article (7), re-quotes the fruit fly experiments of Packard (8, 9, 10) wherein the radiation effect would appear similar, despite variations of ray quality. Aside from any criticism of the method pursued or conclusion drawn, the question still remains whether any inference of parallelism is justifiable between the lethal dose on a thin layer of radiosensitive *Drosophila* eggs and reaction of a similar dose to the highly vascular human tissue mass.

Packard in one of his conclusions clearly states that "*The eggs of the fruit fly, Drosophila, can be used as a dosimeter for estimating x-ray dosage*". There is the further suggestion that the lethal dose of

¹ Presented in synopsis form on Dec 5 1934 in a Symposium on Physics of Radiation at the Annual Meeting of the Radiological Society of North America at Memphis, Tenn.

Drosophila eggs may be a supplement to, or substitute for, iontoquantimetric dose estimation in r, but "biologic variation cannot now be excluded"

At the recent (June, 1934) meeting of the American Medical Association, in Cleveland, Hodges (11) reported the results of experiments on animal and human skin, wherein the attempt was made to show that the radiation effect is uninfluenced by ray quality. Some of the material presented reveals such wide variations in reactions that the inference appears inconclusive and would rather tend to substantiate our observations.

Who of you does not apply a greater dosage as measured by ionization with the higher voltage and filtration in deep therapy, as compared with the longer wave length treatment of superficial skin lesions?

If a fixed number of r results in a similar reaction, irrespective of voltage and filtration, then why this disparity in practical application at most of the largest clinics in the country?

Invariably the dosage (expressed in r ionization measurements) is numerically far greater when higher voltage and stronger filtration is employed than with

the softer ray, skin therapy technic. A review of the literature and the most recent presentations further substantiates this fact.

Again, at the 1934 Cleveland meeting, and since published (12), MacKee and Cipollaro presented a survey of quality dose measurements as applied in radiation (skin) therapy and came to the conclusion that the erythema (skin unit dose) averages about 325 r (measured in air).

In a report published by Andrews and Braestrup in 1933 (13), a similar survey revealed 400 r as the skin unit dose. In the race to present such material Eller and Mutscheller (14) preceded Andrews by a month with 340 r as the skin unit dose. Some of these authors kindly referred to our "pioneer" work in this field. In all, the voltage is comparatively low—75 to 100 K V, with little or no filtration other than the tube wall.

Turning to higher voltage and stronger filtration—from a Memorial Hospital report (15) one observes that 540 r is the threshold erythema dose of the workers in that institution when employing 200 K V and 0.5 mm Cu filter.

TABLE I—SHOWING THE RELATION OF IONIZATION MEASUREMENTS TO SKIN REACTION WITH VARIOUS RAY QUALITIES

(As employed in several New York institutions)

Reference No	Sponsors	Voltage K V Peak	Filtration in mm	r by ionization in air
14	Eller J J, and Mutscheller A	78 to 97		340 average
13	Andrews G C and Braestrup C B	$\begin{cases} 100 \\ 135 \end{cases}$	$\begin{cases} 0 \\ 3 \text{ Al} \end{cases}$	$\begin{cases} -400 \\ +400 \text{ to } -500 \end{cases}$
12	MacKee G M and Cipollaro A	100		325 average
15	Memorial Hosp Group	200	0.5 Cu	540+
Personal communication	Lenz M Presbyterian Hosp Montefiore Hosp	200 M R ¹ or 180 C P ²	0.5 Cu	+600
Personal communication	Harris William Mt Sinai Hosp	200 M R ¹ or 180 C P	$\begin{cases} 0.5 \text{ Cu} \\ 2 \text{ Cu} \end{cases}$	$\begin{cases} -600 \\ +650 \end{cases}$
Refs 2-6 inclusive	Meyer W H Meyer and Glasser Meyer and Braestrup Meyer and Mutscheller	$\begin{cases} 75 \text{ to } 100 \\ 130 \\ 200 \\ 200 \text{ or } 180 \text{ C P}^2 \end{cases}$	$\begin{cases} 0 \\ \frac{1}{4} \text{ Cu} \\ \frac{1}{2} \text{ Cu} \\ 2 \text{ Cu} \end{cases}$	$\begin{cases} +350 \\ +450 - \\ -600 + \\ +700 \end{cases}$

¹ M R = Mechanical Rectification
² C P = Constant Potential

From further sources including the Mt Sinai, Montefiore, and Presbyterian Hospitals in New York City, the information is gained that with 200 KV and 0.5 mm Cu filter, the dose administered approximates 600 r, whereas with 2 mm Cu filter 700 r more nearly approaches a threshold erythema dose (all measurements in air)

Whereas our earliest work (2) was based on a rather definite erythema reaction with measurements inclusive of back-scattering, our skin unit dose to-day is nearer a threshold erythema with scalp epilation as the actual unit of measure. The calibration of instruments used in our early work also had a greater number of the old R per division of the scale than the standard small r calibration of to-day; therefore, the

present measurements, as made by ionization in air, show a curve on a given chart somewhat lower than that first published. Nevertheless, the character and general pitch of the curve remains practically the same.

In Table I a condensed summary of the collected data, inclusive of our own, is presented.

The chart herewith published forms a composite survey of our cumulated experience and is the basis of all our radiation dosimetry. Though some of the comparative data are probably not sufficiently accurate to escape the critical physicist, nevertheless, for the therapist this chart should be of practical value in linking the physical measurements and calibration of

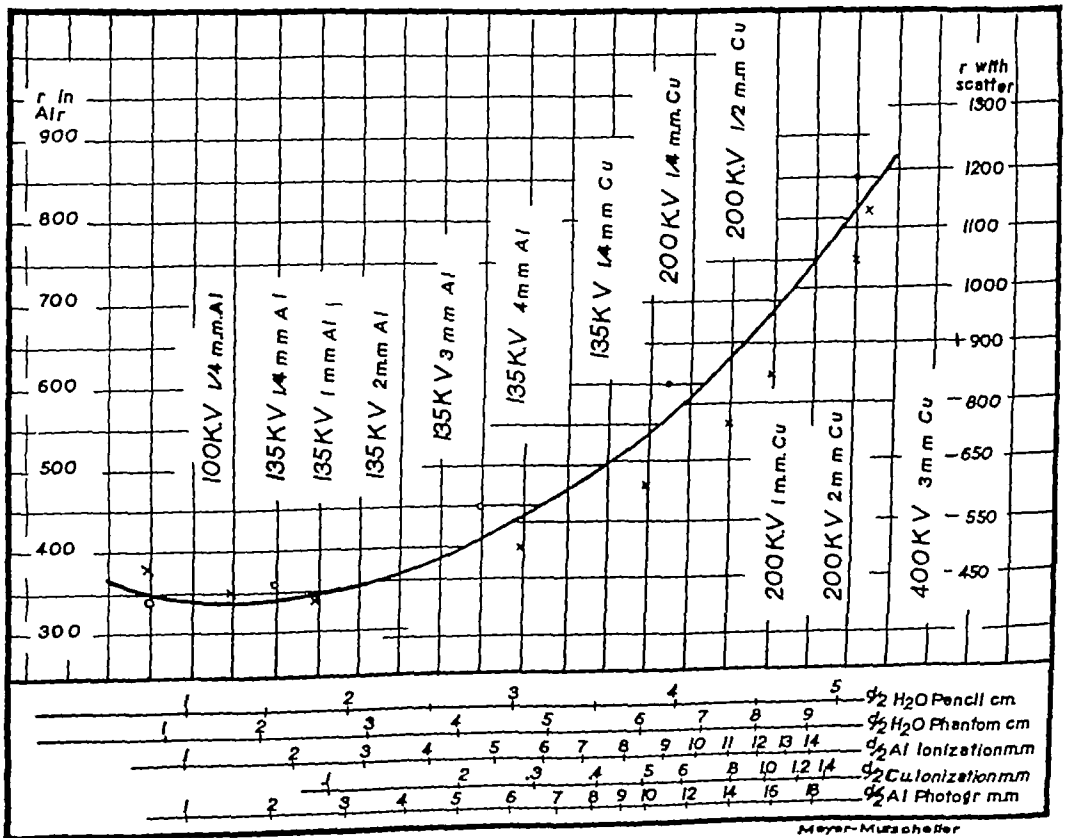


Chart showing the influence of ray qualities on the dose (expressed in r) for a given epilation (erythema) reaction.

(Acknowledgment is made of the writer's indebtedness to Dr. A. Mutscheller for his assistance in checking the physical data as well as in preparing the chart.)

Note: O = Data submitted by Glasser, X = Data (experimental) by Meyer

equipment to the variations of everyday radiation therapy. In the left-hand vertical column the ionization r measurements in air are indicated. To the extreme right appear the approximate r as measured on a large phantom through a large portal (*i.e.*, with back-scatter). Horizontally at the bottom in the first line, the figures represent the half value layers of a pencil beam in water. Below this, for the purpose of ready reference, some other practical qualitative measurements are listed in the approximate position of their respective values.

Since there is to date naught else that visualizes more clearly the relation of quality to quantity, and at the same time permits of simple designation, we adhere to the *half value layer*, in a given substance, as the *measure of quality*.

Various points on the curve (in the above-mentioned chart) indicate, in the vertical column, the quantity in r required for a given skin reaction (epilation, erythema), with the different ray qualities listed at the bottom of the chart. Some of the practical every-day working technics are indicated across the top of the chart, again approximately in their relative position to the actual qualities obtained.

It is, of course, apparent that the higher the voltage and the stronger the filtration the greater is the relative r measurement for a given reaction. In the main, the data on the chart correspond closely to those we reported in our early findings. It will be seen that with low voltage (± 100) K V and weak filtration (0.5 mm Al), the epilation (erythema) dose is recorded as about 350 r (in air). At 200 K V and 0.5 mm Cu, 550 to 600 r are recorded, and when +2 mm Cu as filter is employed, the r measurement in air averages between 650 to 700 r . It might also be mentioned that most of these figures, reported by us many years ago are in close agreement with the practices of some of the larger institutions to-day.

If one will but observe the ever-increasing half value layer with increasing voltage and filtration, then the reason for quanti-

tative variation with the present-day measurements in r should be evident. Truly mass absorption must be the index of reaction in any given form of tissue.

CONCLUDING DISCUSSION

There are, perhaps, one or two points not sufficiently stressed that appear on the chart.

First, I wish to express my appreciation to the discussants and most particularly to the Memorial Hospital representative. Is it, however, not a question whether reaction on *Drosophila* eggs may be one thing and living human tissue reaction, with its rich vascular and lymphatic supply, another?

A point not evident in the chart but brought out by the discussion is that the measurements are influenced by the wall thickness of the ionization chamber. Frankly, I do not believe that the wide variation in r measurement in relation to skin or biologic reaction is entirely to be ascribed to the thickness of the chamber wall.

Another point deserving of thought is the peculiarly constant index figure that appears—namely, if with a given ray quality one multiplies the half value layer of a pencil beam in water with the figure 150, it is remarkable how close is the estimate of the r required (as measured in air) to result in a uniform erythema skin reaction.

In conclusion, I wish to reiterate my belief that, except for variation in radiosensitivity, in mass absorption will the secret to biologic or, rather, human tissue reaction be found.

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DISCUSSION OF SYMPOSIUM ON PHYSICS OF RADIATION

DR A N ARNESON (New York City)
A description of the exhibit will, of course, be a brief repetition of the paper that has already been presented. The exhibit consists of a number of diagrams illustrating the distribution of radiation obtained throughout the average female pelvis in the treatment of cervical cancer, for a variety of port arrangements. These diagrams are shown for target-skin distances of 50 and 70 centimeters.

The size of the pelvic diagram used in the preparation of the charts was determined from measurements made upon several patients with cervical cancer. The measurements were made in a plane passing through the heads of the femora, and the

upper border of the symphysis pubis, which was chosen to represent approximately that of the cervix. The average anteroposterior and lateral diameters were 23 cm and 35 cm, respectively. The distribution of radiation shown for each port arrangement considered, is that which would exist within a pelvis of the dimensions specified. Patients of smaller size would receive a greater percentage depth dose, and those of larger size would receive a lesser percentage dose.

If large fields were used on the anterior and posterior pelvic surfaces, they measured 15 cm longitudinally and 20 cm transversely. If two small fields were used on these surfaces, they were 15 cm longitudinally and 10 cm transversely. Since the total irradiated skin area on both the anterior and posterior surfaces is the same in all of the diagrams, and the size of the pelvis is constant in each instance, the diagrams may be used for comparing the advantages and disadvantages of the different port arrangements considered.

If two beams are directed straight into the pelvis on both the anterior and posterior surfaces, without tilting toward the mid-pelvis, and if the fields are separated in the mid-line by a distance of 2 cm, then the bladder and rectal regions are spared doses in excess of the amount delivered to the cervix. When radium is applied to the primary lesion, which will control the disease within a distance of 3 cm, or perhaps 4 cm, from the cervical canal, a greater dose will be delivered to the cervix than to the bladder or rectum. The addition of lateral beams increases considerably the dose delivered to the parametrial regions, but adds very little to the dose reaching the mid-pelvis.

The doses delivered to the cervix, and to points 2 cm apart along a line drawn directly lateral to the cervix in the transverse diameter, are shown within a diagram of the pelvis for each of the port arrangements that have been considered. These values illustrate that the tumor-bearing area receives the greatest amount of radiation when lateral fields are employed. The ad-

vantages of using two ports on the anterior and posterior pelvic surfaces have already been discussed. A six-field arrangement, therefore, employing two fields on the anterior, two on the posterior, and one on each lateral surface, delivers the most suitable distribution of radiation for the treatment of cervical cancer.

The distribution of radiation obtained from two anterior fields has been illustrated radiographically. The level of the cervix was marked with an opaque material, and a flat plate of the pelvis made. Before disturbing either the patient or the cassette containing the film, exposures were made through each of the two anterior ports, with the beams oriented and directed in the usual manner for treatment.

It can be seen that the beams include the promontory of the sacrum, as well as the cervix and uterus. Unnecessary abdominal irradiation is avoided, and the external genitalia are not exposed to the direct rays. The upper border of the fields is at the level of the iliac crests, and the lower border located about the middle of the symphysis pubis. If the fields are 15 cm long, they will usually extend between these two bony landmarks, which can be used for marking out the pelvic ports on the anterior, posterior, and lateral surfaces.

DR EDITH H. QUIMBY (New York City)
I have been very much interested in this group of papers on the physics of radiation. I think your Chairman is to be congratulated on having assembled such a symposium, and particularly on finding two such satisfactory "pinch hitters" to take the place of absentees.

Each paper deserves more thorough and careful discussion than is possible in the few minutes at my disposal. With the exception of Dr. Stone's¹ and Dr. Arneson's papers, every one is to a certain extent concerned with the physical measurement of gamma-ray intensities. This is one of the most important problems for the radiolo-

gist at the present time. We are all anxious to express radium and x-ray doses in terms of the same unit. This anxiety has led in some instances to a premature adoption of the roentgen as the unit for gamma rays. Certain experiments carried out under specified conditions have given definite values for the number of roentgens corresponding to 1 milligram-hour of radium at a distance of 1 centimeter. These experiments have been carried out, for the most part, with small closed ionization chambers, and it has not been possible to comply with all the requirements of the definition of the roentgen. This definition states specifically, "—when all the secondary electrons are utilized, and the wall effect of the chamber is avoided—" For 200 KV x-rays it is possible to meet these specifications with the standard open air chamber. Within a certain range of quality the small "air-wall" chamber has been found, under proper conditions, to give the same values as the standard chamber. As the energy of the rays increases, it becomes more difficult to build an open air chamber which will meet the requirements. The small closed chambers never did meet them, it simply happened that they gave the correct values, within a certain range. As the wave length decreases, the effect of wall material and wall thickness becomes more important. The size of the chamber, and its distance from the source also come into consideration. Experiments made at the Memorial Hospital, and reported by Dr. Failla at the Fourth International Congress of Radiology, show the importance of these factors. Measurements of the radiation from radium, by means of spherical ionization chambers of various sizes placed at different distances from the source, show an increase in the value of the output as the distance is increased, even up to 10 meters. (Due allowance has been made for the inverse square law, but none for the absorption of radiation by the air.) Scattering from the air in the room, as well as from solid material, has been shown to be a factor which must be considered. With regard to the chamber material, it has been

¹ Published in two parts. *RADIOLOGY*, February 1935 24, 133-139; March 1935 24, 298-302.

shown that as the density and atomic number of the material increase, the ionization also increases. Various workers have shown that, with chambers of organic materials, the ionization increases up to a wall thickness of about 4 mm, and is constant after that. For this reason they have suggested the adoption of such a chamber as standard for gamma-ray measurement.

It is evident that it is impossible to measure gamma rays in roentgens according to the present definition. The physicist may establish an arbitrary set of conditions for distance, chamber specifications, etc., and say this shall represent the roentgen—in effect, he is changing the definition. And when physicists agree upon such changes, they must keep in mind, as Dr Meyer has reminded us, the biological applications of the measurements. If, for instance, we decide on an ionization chamber with a wall of 4 mm of celluloid, we must remember that the radiation within this is not the same as the radiation at the surface of the biological material—that is not surrounded by a celluloid wall. The physicist, with such a chamber, can measure the radiation under his set of conditions, and can tell when this is duplicated, but he cannot make biologically accurate measurements when he changes from one set of experimental conditions to another.

In this connection we may consider Dr Meyer's work on the varying amounts of radiation necessary to produce erythema for different qualities of radiation. From the clinical point of view, this is an exceedingly important problem. Almost everyone is agreed that with increase in wave length, the amount of radiation required to produce this reaction decreases, down to a certain point. Here again comes the problem of how the radiation is to be measured. The question of the use of *Drosophila* eggs as a standard, because of their wave length independence, has been brought up. Actually they have never been shown to be independent of wave length in their response to radiation. It has been shown that, over a certain range, they respond in the same manner as the "air-wall" ionization cham-

ber, that is all. At the Memorial Hospital, where we have compared the effects of 200 K V x-rays, 700 K V x-rays, and gamma rays, on the basis of ionization as related to three chemical and three biological reactions, as well as to human skin erythema, we have found almost as many different relations as we had experimental subjects. The problem is a very complicated one.

In order to emphasize this, I might mention the values obtained for the number of roentgens emitted per minute per gram of radium, with a filter of 0.5 mm platinum, at a distance of 1 cm, by a study of various reactions, all being investigated under as nearly identical conditions as possible. With a certain small applicator holding the radium 1 cm from the skin, by producing the same type of erythema as that resulting from a known quantity of 200 K V x-rays, Dr Arneson and I determined for the radium an output of 88 roentgens per minute per gram. Using the same applicator, with both wheat seedlings and *Drosophila* eggs, Dr Henshaw found an output of 66 roentgens. With an ionization chamber of exactly the same size and shape as the applicator, Dr Failla and Mr Marinelli found an output of 55 roentgens. This demonstrates the difficulty of linking physical and biological measurements. It is impossible to take any one biological reaction, be it erythema, epilation, killing of *Drosophila* eggs, or anything else, and assume that it will express all biological reactions for all types of radiation. It is very fortunate, from a therapeutic point of view, that this is true, if there were no difference in response between different types of tissue, radiation therapy would not offer much clinical hope. Such therapy is built upon an assumption of differential response from various tissues.

The measurement of ionization in liquids, described by Dr Taylor,² seems one of the most promising lines of investigation of the amount of radiation actually delivered within the tissues. Dr Failla and I made

² Dr Lauriston S. Taylor, of the Bureau of Standards, Washington, D. C., was the leader of this Symposium. He expects to publish his paper later in the year.

some investigations along these lines some years ago, but encountered such experimental difficulties that we postponed further work. I am delighted to know that Dr Taylor has found a practical method for making such measurements in liquids having molecular structures sufficiently like tissue.

Calculations of the sort presented by Dr Laurence are of great importance in the development of interstitial irradiation. He has found it necessary to make separate tabulations and computations for every different arrangement of needles. He will, however, probably find it possible to make some simplifications so as to render his data more readily available for the practising radiologist. At the Memorial Hospital we have made similar calculations for the distribution of radiation around needles, and have been able to construct a table (*Am Jour Roentgenol and Rad Ther*, 1935, 33, 315) for dosage when needles are used throughout a lesion. With the type of irradiation in which he is especially interested, in which the source of radiation is outside the lesion, a different type of table would be necessary.

Dr Stone's report³ is of great interest to all of us who are concerned with high voltage x-rays. His equipment has some marked advantages over many of the other types, and we all want to know what it does and how it does it.

Dr Arneson's paper has a more direct clinical appeal than the others on this program. His charts are presented in the Scientific Exhibit, and a question has been asked several times as to their degree of accuracy. Anyone who has made isodose charts knows that values along the axis of the beam should be good while those along its edges are uncertain. For the purpose for which these charts were intended, namely, a comparison of methods, the charts are of sufficient accuracy to warrant the conclusions drawn. As an actual statement of dosage, they cannot be considered to be closer than about 10 per cent, and possibly some deviations are greater. Vari-

ations of this amount are not significant for clinical purposes. It must be remembered that doses taken from these charts are correct only for a pelvis the size of the one used. For a large, fat woman, the dose delivered at a given point might be considerably less.

G. C. LAURENCE, Ph.D. (Ottawa, Canada) I should like to say something about that number—the ratio between the dose in roentgens and in what we have called milligram-hours per centimeter squared (Imc-hr). Some values obtained by different writers have been quoted—they differ somewhat. These differences are due partly to experimental errors no doubt, but mostly to differences in the definition of the Imc-hr which they have adopted. We have verified this experimentally by actually making measurements under the experimental conditions called for in the definitions. I have already stressed this unsatisfactory feature of the unit.

Since we have deduced the dose in roentgen from that determined in Imc-hr by multiplying by this number, one might perhaps expect that our values in roentgens were dependent on the peculiarities of the definition of the Imc-hr adopted. This is not entirely true. The peculiarities of the definition are taken into account in the value of the number. Consequently, the peculiarities are eliminated. In other words, the experimental conditions which obtained during the measurement of the physical variables which are involved in obtaining the dose in Imc-hr are either reproduced in determining the ratio between the two units or else correction is made for them mathematically. When this has been done the uncertainty in the dosage in roentgens on this cause is appreciable but not serious, in comparison with biological uncertainties.

Another point raised by Dr Quimby she referred to the work they have been doing in measurements of the dosage distributions in tissue in which they have a grid-work of radon units. In these calculations which we have made, we had in

³ See Footnote 1 page 203

mind more the type of technic in which the radium is placed outside the tumor, placed above it—a technic which, I believe, is more common in Europe and in parts of Canada. In such work the dose does depend greatly on the design of the radium units.

There is another point I would like to make and that is in regard to the relationship between physical dosage and biological effect. The physicist does not claim, does not believe, that biological effects can be

expressed in such a way that one can numerically proportionally correlate them with dosage measured in roentgens, *independently of the quality*

The variation of the dosage required for epilation with quality which was shown in the slide a few minutes ago, is the kind of variation which the physicist might expect from purely physical considerations. I think there has been misunderstanding on that point.

THE TREATMENT OF ADVANCED MALIGNANT DISEASE¹

By LIONEL S. AUSTER, A.B., M.D., *New York City*

From the New York City Cancer Institute and Hospital, Dr. Ira I. Kaplan, Director

AS THE education of both the medical and lay public advances, the realization will take hold that the therapy of cancer is a group problem rather than an individual task. This will eventually aid in the reduction of early morbidity and mortality. But at present the material at the New York Cancer Institute and Hospital bears evidence that the common attitude of the profession too frequently is one of fatalism, with an all-too-pervading sense of original omniscience and omnipotence. This impression is based upon the fact that the majority of cases admitted to our hospital are instances of the following serial progression of events: (1) Attempts to treat malignancy in its early stages with an inadequate program of therapy, (2) the recurrence or progressive course of the disease, (3) the baffling prospect of the terrifying morbidity which may precede death, and (4) final release from responsibility by transfer of the patient to a hospital or clinic such as ours, which is unique in its facilities for harboring large numbers of these patients for indefinite periods of time.

This attitude might be condoned if all these patients were indigent persons sent merely for terminal custodial care, but most of them, while late, are individuals whose lives may be, and usually are, extended in comparative comfort for long periods. Many of our patients are discharged home as cured or arrested cases, to return for ambulatory observation, treatment, or subsequent hospitalization, over many years, and our resident population numbers some who have been with us for over seven years.

It is on this account that we have

¹ Read before the Annual Conference, Division of Cancer, Department of Hospitals, City of New York, April 10, 1935.

adopted the feeling that, except in obviously terminal disease, we can never give up trying. The purpose of this communication is to attempt to postpone the usual discussion of euthanasia which arises in the presence of late malignancy, and offer some thoughts based upon our not-always-successful experience in the handling of advanced malignant neoplasms, with the hope of mitigating the patient's discomfort and prolonging his life if he can be freed of the active symptoms of disease.

CLASSIFICATION

The treatment of advanced malignancy falls into two general categories: attempts at cure, and palliation.

The initial classification of the patient is determined by whether his lesion is still localized and amenable to extirpation and/or control by a combination of the agencies at our disposal, or whether, in the presence of recurrent, bulky, inaccessible, pathologically resistant or disseminated disease, the most we can offer is palliation and general systemic support, with amelioration of local symptoms.

The facilities at our command are medical, surgical, the use of radiation in the form of radium or roentgen ray, and the newer combination of radium-surgery—any or all of these. The therapy must be applied in all cases with a consideration of the individual patient, and takes the form of general and local measures.

GENERAL CONSIDERATIONS

In the general grouping, the chief difficulties in the late stages of cancer (the term here is used to denote all malignancy) are those of a systemic nature which may be secondary to the disease or its treatment, or may be wholly independent

thereof but accelerated thereby. In the latter group are those degenerative diseases which are most common in persons of advancing years, and, in the presence of the malignancy, the patient's cardiovascular and renal apparatus can nevertheless be the cause of his death, and frequently is. Diabetes and tuberculosis make great headway in the frequently undernourished cancer patient and, except in the presence of terminal states or liver involvement, there has never been a good reason advanced against the feasibility of treating syphilis in these individuals. Indeed, arsenic therapy is usually of considerable benefit from a hematinic and tonic standpoint.

That ill-conditioned state of body and mind comprising weakness, malnutrition, asthenia, anemia, and depression, which we call cachexia, is a symbol of bodily degeneration which, imperceptibly advancing, brings to the late case an unmistakable appearance associated with wasting disease. But frequently our therapy may cause its supervention as well as delay it. In the well deserved acceptance of radiation as the method of choice in treatment of many lesions, the enthusiasm of the therapist must be stayed by the realization of the general systemic effects of this powerful agent. Patients vary in their tolerance of the large doses now in vogue, and the reaction of the hematopoietic system must be carefully gauged, particularly in view of the late effects seen with production of anemias similar to those of the primary type in severity. The use of frequent and adequate transfusions, when blood is available, is imperative in anemias both acute, following hemorrhage, and of chronic course. The liberal administration of venous and hypodermoclyses of glucose and saline solutions during periods of stress, asthenia, and dehydration are urged. Physical therapy, particularly the use of ultra-violet light, cheerful surroundings, adequate nutrition, meticulous care in nursing, and personal hygiene have obvious advantages.

THERAPY OF PAIN

The problem of pain is the most distressing of all—to the patient—in advanced malignancy. Pain almost always occurs eventually in the course of this group of diseases, sometimes very late, and sometimes of evanescent character. But usually when it arrives it is constant, increasing in severity, debilitating, and is probably the most potent factor in the undermining of the morale of these sufferers. The pain may be incidental to the local lesion, may be the result of local extension with invasion of perineural lymphatics or destruction or involvement of sensory nerves, or may be the result of distant invasions which encroach upon tissues far from the primary lesion. These last pains are frequently mistaken for adventitious symptoms in the presumably early course, only to be revealed as the first evidences of definite metastases when the trained observer recognizes their significance. The repeated stories of "rheumatic pains," "growing pains," "arthritis," "intestinal headache," "pleurisy," and "sciatica," in cases of skeletal and pleuropulmonary dissemination, are all too common in thousands of histories.

The treatment of pain must be undertaken with a realization of the causative factors. General medication with hypnotics and analgesics is necessary, and although we feel that terminal stages require liberal use of narcotics, the administration of opiates should be limited in those instances of probable long duration, on account of the dangers of habituation and raising of the threshold of effectiveness. Moreover, it has been found that acetyl-salicylic acid and the coal tar group (sometimes in association with small doses of the barbiturates or even, when necessary, fractional amounts of codein) are usually effective in controlling general symptoms for extended periods. Amidopyrin, acetphenetidin, antipyrin, and acetanilid are analgesic medicaments of increasing potency, in the order named, for the vast majority of pains. Radiation

therapy is of inestimable and dramatic value in controlling the pain of bone metastases. Local nerve or spinal block, or the newer surgical attacks on the parasympathetic system are remarkable measures for the control of regional symptoms.

APPRAISAL OF SURGICAL RISK

At this point it may not be amiss to interpolate a word concerning the general problems confronting the surgeon in these cases. The technical development of the surgeon's art has reached a point beyond which there is little room for improvement except in individual development of skill and the perfection of team work. However, the hazards of these technical procedures are both real and ever-present, though, for the most part, intangible. In fact, the surgery of malignancy at this time has in many cases overreached itself, with the result that many men of wide experience and unquestioned ability have begun to exercise that better judgment developed as a result of these qualities, and are relegating more and more of the pathologically qualified lesions in difficultly accessible locations to the radiation therapist for primary treatment. Moreover, the rôle of radiation in the diminution of initial bulk of radiation-sensitive tumors makes many of them more amenable to later surgical extirpation, just as the local surgical removal of more adult type neoplasms diminishes their accessible bulk to a point at which interstitial or external radiation may prove effective. But the mere fact that a patient harbors a malignant neoplasm immediately makes that individual a greater operative risk. This is especially true of intra-abdominal tumors. We have all seen exploratory operations performed with speed and a minimum of shock, with no actual surgery having been performed in the abdomen, and the patient returned to bed in excellent condition, only to die within the week. It is, therefore, incumbent upon the surgeon to refrain from excessively extensive procedures in patients with recurrent or long-standing, progressive, ne-

crotic, or infected lesions, but to realize that palliative procedures may be of great benefit and give abiding comfort.

CHOICE OF ANESTHESIA

In view of the greater risks in these patients, the choice of anesthesia becomes of even greater importance. It has been found that the development of skill in the use of local infiltration and nerve block analgesia is an essential in the successful treatment of these people. Operations of considerable severity or extent can be performed with lessened danger by this method. For rapid procedures, particularly about the head and neck, in the absence of respiratory embarrassment, evipal-soluble given intravenously has been most satisfactory, giving control over an unconscious patient for periods as long as a half-hour. Our experiences with this agent have been reported recently by Dr Livingston.

I am personally partial to the use of rectal or colonic anesthesia, preferably with paraldehyde as the base, and possibly the addition of a small amount of ether and oil in instances in which operations of greater length or severity are contemplated. The chief advantage of this method is the apparently semi-conscious state maintained, with absolute analgesia and complete loss of memory of any occurrences. The patient's mental trauma is minimal, he falls asleep in bed and wakes up there. It is particularly adapted for head, neck, and breast work or extensive plastic reconstructions.

Low abdominopelvic operations, urologic and gynecologic surgery, and amputations or other work on the lower extremities are best handled by spinal or sacral epidural injection. This is also an excellent and much to be preferred method for general abdominal work, but the selection of cases must be made with due attention to the general condition of the patient and the presence of active or latent sepsis. In the presence of a distant active infective focus, such as a sinusitis, the intro-

duction of a needle into the spinal canal for analgesia may produce a meningitis

There are numerous symptoms and situations which arise in advanced cancer patients which are referable to specific neoplasms of regional distribution

HEAD AND NECK

Brain tumors usually require only custodial care in their late course, the patient needing nursing care and feeding, most of his existence being in partial or complete coma. However, patients may go on for long periods, sometimes living in this state for over a year

Skin cancer, particularly that of the face, scalp, and nose, still is a fatal disease which runs a prolonged course and presents complex problems in its management. The recurrent basal-cell epitheliomas especially, which, instead of metastasizing to lymph nodes, recur and extend locally, with destruction of soft tissues and of bone, producing severe hemorrhage, infection, pain, and interference with nutrition, must be attacked repeatedly from many angles as the disease progresses. Ligations of major vessels at points of origin and carotid ligations, when necessary, must be undertaken while tissues are still available for a clean approach. Cautery and electrothermic resections are salutary methods for the removal of sloughing bleeding masses. Drainage and local surgical measures should not be withheld from those cases of disease in the cavities of the skull, which often show marked symptomatic improvement and arrest after the release of exudates and necrotic tumor detritus, possibly preceded by nutrient arterial ligation, and followed by successive courses of radiation

The lesions of the tongue, lip, cheek, gums, salivary glands, and tonsils are pernicious on account of their progressive recurrent nature, partial inaccessibility, and pain. With the exception of the tonsil and its bulky extensions, most of the other mouth lesions are accessible in some degree for local attack in all their stages. The use of endothermic and scalpel excisions

is rapidly superseded, however, by the necessity of reliance upon interstitial and topical radiation. Bone necrosis requires incision and drainage of abscesses and eventual sequestrectomies. Mandibular spasms and contractures as a result of radiation effect on tumor, joint ankylosis, or pain must be treated by trigeminal nerve block, anesthesia, and forcible stretching, or masseter or mandibular ramus section. Mouth hygiene, with due attention to teeth and extraction for feeding, is usually overlooked. Deep infections of the submental region and neck require drainage. The eventual inanition as a result of inability to eat or swallow can be forestalled or aided by a simple gastrostomy. We prefer the Jane way type, done under local infiltration analgesia. Irrigations with mild solutions of chlorine-containing fluids are the most effective for control of the intra-oral fetor and indolent ulcerative suppuration, and mouth-soluble tablets of local anesthetic action, such as euphagin or anesthesin, are greatly appreciated for the control of local mouth and pharyngeal pain. Trichlorethylene has given satisfactory results in pain of trigeminal distribution.

Cases presenting defects in the facial walls following extirpation of the neoplasm can often be rehabilitated by proper reconstructive or plastic surgical procedures. Initial therapy in these cases should always be planned with an eye to later reconstruction. The wholesale sacrifice of tissues makes these subsequent repairs increasingly difficult, if not impossible, whereas cases of curable cancer can and should be handled with the end-result in view.

Laryngeal carcinoma is usually seen late but nevertheless has a long life expectancy with great discomfort. Repeated treatment by divided doses of radiation has kept these individuals going if early, low tracheotomy is performed to relieve respiratory embarrassment, and gastrostomy performed for feeding, when indicated. The necessity for low, mid-line tracheotomy must be stressed on account

of the fact that the high operation invariably adds to the complexities of the individual's existence because of early infiltration by the advancing, infected tumor. The larynx becomes fixed, the tracheal fistula distorted and obstructed, the tube irreplaceable, and the terminal aspiration pneumonia, with which most of these patients die, occurs earlier. Tracheotomy, moreover, can best be performed with ease and convenience before radiation in advanced cases. When deferred, it must frequently be undertaken as an emergency measure, and the danger of massive necrosis of the devitalized radiated tissues is not unreal.

CHEST

Pulmonary and mediastinal infiltrations will require thoracenteses at increasingly shorter intervals and cardiac support for the vascular obstructions at the base of the heart. Radiation in carcinoma or its equivalent is occasionally of temporary value, usually increasing the patient's symptoms on account of early engorgement and swelling, with possibly a later interval of decrease in symptoms. These patients, however, return soon after their temporary relief and die with massive infiltrations causing complete great vessel obstruction. In this location, however, the lesions of lymphosarcoma and malignant lymphogranuloma may be treated with more success, their diminution of compression symptomatology and radiographically visible bulk often occurring many weeks after treatment is completed.

The treatment of granuloma malignum merits a word in connection with the frequent misconception of the goal aimed at here. The pathology of Hodgkin's disease is one showing a serial progression of lymphoid tissue changes ranging from characteristic cellular hyperplasia to hyalinizing fibrosis. It is irrational to attempt always to treat for complete disappearance because the patient invariably presents masses which include both early and late types of lesions. The early ones of marked cellularity regress rapidly under

prolonged radiation. Those in later stages are stimulated to progress in their natural course—that of fibrosis and hyalinization—which represents a healing stage. This is the end-point and should be our desideratum. With radiation applied to effect fibrosis, excessive radiation beyond this point endangers the general body economy and does nothing further for the deep lesions. They must then be watched carefully only for signs of further or recurrent activity and further radiation instituted at properly spaced intervals.

The pneumonias and purulent effusions which occur as terminal states in so many of these patients suggest the paradoxical statement that patients with cancer seldom die of cancer. Their neoplasia is merely the activating factor in a train of circumstances which produces eventual death. Patients with lesions in the head, mouth, pharynx, and larynx usually end with aspiration pneumonia. Post-operative cases of all sorts are prone to cardiovascular collapse and pulmonary infection. Hemorrhage and sepsis are high in the list, and the necropsy findings indicate that a much higher percentage of these individuals die of the ordinary degenerative diseases than we realize or admit, with inanition a provocative factor.

GASTRO-INTESTINAL TRACT

Early gastrostomy in obstructing esophageal lesions, before the patient's malnutrition has impaired his powers of withstanding operative intervention, will cause both local and general benefits to become apparent. The same principle holds true in cases requiring gastro-enterostomy for pyloric obstruction and colostomy for lesions in the lower bowel. Dr. Yeomans' recent analysis has shown the benefits of these procedures by unmistakable statistical and case demonstrations. These procedures are justifiable even in the presence of liver involvement without clinical derangement of liver function. We have seen numerous instances of almost unbelievably extensive hepatic invasion without jaundice until just before

death, because the deposits were fortunately parenchymal without duct impingement to cause biliary obstruction.

Abdominal ascites requires frequent paracenteses, and definite obstruction should merit early operation for relief, since we have seen many instances exemplifying the operability of conditions which terminated in death. There are occasional instances too in which intra-abdominal pathology unrelated to malignancy is encountered, although the medical attendant usually overlooks the appendicitis or strangulated hernia in the face of intra-abdominal cancer.

BREAST

Cancer of the breast presents abundant opportunity for palliative treatment. The removal of bulky masses with either frank or impending ulceration is a mercy, relieving the patient of a foul malodorous lesion which may be either immediately closed or left to granulate for eventual secondary healing or possibly skin grafting. Even the incomplete removal of bulk facilitates the approach by radiation therapy and the control of many otherwise hopeless lesions. These primarily bulky masses are usually of better prognosis than the small infiltrating lesions with rapid recurrence and wide dissemination. In some types of recurrent localized duct-cell tumors, repeated excision with continued repeated radium and x-ray applications have kept patients on the active clinic roster for six and seven years. The very extensive skeletal infiltrations seen in some patients, in which their bones are riddled with metastases, are of relatively better prognostic significance than the single large painful deposit occurring in the spine or head of an extremity. These patients with honey-combed skeletons are usually relatively free of severe discomfort and can be kept going, much as are cases of multiple myeloma, for many years by repeated rotating cycles of high voltage radiation, with, of course, due regard for the blood picture.

The widespread skin infiltrations seen in recurrences described as *en cuirasse* are resistant and relentless, usually killing by their pleuro-pulmonary extension through the lymphatics of the chest wall despite the restraining influence of radiation.

We do not believe in the effectiveness of attempted *radical* surgical extirpation of so-called acute inflammatory carcinoma in young women, primary inoperable carcinoma with bulky axillary involvement or supraclavicular extension, or apparently primary operable lesions, which fall into the inoperable class as a result of skeletal or pulmonary metastases which are picked up by our routine radiological examination of all breast patients.

The sterilization of younger women with mammary cancer by radiation of the ovaries is a theoretically effective adjuvant to local therapy, particularly as regards growth restraint, or at least the elimination of the endocrine stimulation to growth or recurrence in these specialized and differentiated tumors. Although we have as yet insufficient experience in our own series with which to assay its value, the reports from the Radiumhemmet are sufficiently encouraging to warrant its trial.

BONE TUMORS AND NEUROGENIC SARCOMA

Although the giant-cell tumor of cystic character is usually amenable to radiation properly applied, some of these change their nature and become truly malignant osteogenic sarcomas both in appearance and course. The virulence of malignant bone, nerve, and fascial tumors needs no discussion. Their therapy by radiation is usually unsatisfactory except in the embryonal types, and their cure by surgery usually impossible on account of early extension. Nerve block, alcohol spinal block, amputation or the removal of operable necrotic bulk and accessible recurrences are all measures which are justifiable and necessary when possible. Despite the recurrent nature and known malignancy of these mesodermal neo-

plasms, palliative results of surprising effectiveness have been obtained. Fungation, infection, and necrosis must be treated with usual surgical techniques. Surgical diathermy and endothermy are invaluable in these instances, particularly on account of their control of hemorrhage.

GYNECOLOGIC AFFECTIONS

A realization of the cause of death in malignancy of the pelvic organs, with the uterine cervix taking first place in frequency of initial lesions, directs the therapy along well-ordered lines. Cervix cancer patients die of hemorrhage and anemia, of sepsis and of uremia. The anemia and hemorrhage occur from eroded craters or from spongy, friable, infected, bulky, fungating masses which grow into the vagina. The control of these symptoms has been almost universally effectual by the application of the methods suggested by Dr. Ira Kaplan. Endothermic resection of the protruding mass of infected tumor-granulation tissue immediately removes the source of the bleeding. Diathermic coagulation of the base restrains further bleeding until the topically applied cork and colpostat containing a relatively small amount of radium maintained for a long period of time can exert its effect, aided by packing. Frequent vaginal, bladder, and rectal hygiene instituted at periodic intervals with changes of the packing is important. This also removes a large infective focus. Following this initial radiation, the external lesion is controlled, and a previously obliterated cervical canal frequently becomes apparent. Drainage of a pyometra can then be instituted, if necessary, by the use of a tube and frequent intra-uterine douches, eventually making the insertion of a radium tandem feasible. High voltage cycles through four pelvic portals complete the program and control lateral extensions and pain in many cases.

In instances in which the pelvis is not completely frozen and the patient is in fair general condition, intractable pain can be effectively relieved by intra-ab-

dominal section of the pre-sacral nerve. Low spinal alcohol block may sometimes be advisable. The urinary disturbances incidental to gynecologic malignancy are those arising first from ureteral obstruction caused not by radiation fibrosis but by peri-ureteral lymphatic invasion with infiltrating tumor tissue. This produces hydronephroses, becoming pyonephroses and pyelonephritides, as a result of ascending infection and a frequent cause of death by sepsis or uremia. Renal operation has not been well borne. Drainage is established by ureteral catheterization and dilatation.

The vesico-vaginal fistulas developed as a result of injudicious use of massive radium dosage administered for short periods, far outnumber those resulting from frank neoplastic invasion with necrosis. (In fact, our impression is that rectal invasion is more frequent.) Their therapy is a bugbear and requires faithful nursing with astringent douches, retention catheters, kaolin insufflations, and the use of urinary antiseptics and sedatives. Mechanical devices, sponges, and operative intervention have been failures in our hands.

Late abdominal extensions with ascites, peritoneal implantations, intestinal obstruction, and distention are the rule in ovarian and corpus carcinoma. Radiation following paracentesis and/or operation with removal of major masses has been sometimes followed by satisfactory regression and clinical cure, although the disease may be present but not protruding.

KIDNEY AND BLADDER

Renal and adrenal neoplasms in their later stages are almost all relegated to the custodial group on account of their widespread extension, although radiation does effectively control symptoms referable to bone involvement. Bladder and prostatic cancer patients obtain prolonged comfort by the institution of adequate suprapubic drainage, and go on for

long periods until they die of hemorrhage, renal sepsis, or pneumonia

SUMMARY

No attempt has been made to cover all the possible situations arising in the largest field of medical endeavor—neoplastic disease—but the outstanding features of possible therapy in most frequently encountered advanced conditions have been considered

The problem of the handling of advanced malignancy has been reviewed also from the general standpoint, with a pre-

sentation of the medical, surgical, and radiological measures designed to provide comfort and palliation

Data in the histories obtained in the types of advanced cases continually referred to the New York Cancer Institute emphasize the necessity for education in the possibilities of treatment in these cases. More particularly do they point to the necessity for trained group handling, with an adequate initial program individually planned for each patient

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"PIED FORCÉ" OR "DEUTSCHLANDER'S DISEASE"

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|||EVEN though the literature on so-called Deutschlander's disease is quite extensive, new articles on the subject continue to appear from time to time. This fact seems to show that there is still a lively interest in the subject, and the numerous theories which have been developed about the genesis of "pied forcé" show by their lack of unanimity that our knowledge of this condition is far from complete. The fact that many of the views about this lesion are frankly contradictory has given us the urge to summarize what is known about the condition both from a consideration of the literature and from our own experience.

The diagnosis of the affection rests primarily on the radiologic findings, which will be our primary concern. We are taking for granted that the radiologic appearance of Deutschlander's disease is so well known in these days that a repetition of the diagnostic errors into which some have fallen need not be repeated to-day. Due to a mis-diagnosis of sarcoma (Dodd) a patient who had Deutschlander's disease had a Lisfranc amputation performed. In another case (Straus), a metatarsal exarticulation was performed, in such a case, Dr Markelloff resected a metatarsal and did a bone graft. It is true that the operation was done in this case not through any error in diagnosis but to hasten the process of healing, and at the same time to obtain a histologic section of the diseased bone.

We do not intend to start with the history of the question, a subject sufficiently well covered by other authors, but we will begin our discussion with a consideration of the nomenclature of the disease in question. Among the terms in common use are "fracture de marche," "Marschfraktur," "l'enflure du pied," "Fussgeschwulst," and finally, "Deutschländer's

disease." Do these names designate different affections, or do they all name differently the same condition? There is a marked difference of opinion on this point. Most German authors draw a distinction between "Marschfraktur" and "Fussgeschwulst," and identify the latter with "Deutschländer's disease." However, it should be mentioned that in Schinz' book there is no mention of "Deutschlander's disease." Osterland, after reviewing an extensive experience with the subject in question, holds the term "Fussgeschwulst" a poor one, for the lesion in question is primarily one of bone. On the other hand, others, for example, Narvi, speak of "fracture de marche" or of "Deutschlander's disease." Among the Russian authors in general, who base their terminology on the German literature, we find the term "pied de marche" as well as "Deutschlander's disease" to distinguish the latter from "fracture de marche" ("fracture de recrue"). We are personally in perfect accord with those authors who are for dropping the term "Deutschlander's disease," first of all because the theories of the embolic and inflammatory origins of the lesion are not confirmed by recent observation, and also because such an affection was described by Breithaupt, in 1855.

But even if we leave out of the question the name "Deutschlander's disease," there still remains the conception of "Marschfraktur" and of "Fussgeschwulst" to be clarified.

From a general review of the symptomatology of the disease in question, it appears that "fracture" occurs generally in military life after a march or a drill, whereas the swelling (*enflure*) occurs primarily in civil life. One comes to the conclusion, especially if one bases one's opinion on the German evidence, that the

first term applies to an acute appearance of symptoms, while the second is a slower process, taking place as the result of a morbid background. But there are, as will be seen later, a whole series of transitional stages between the two forms. That is the reason why we side in with the American and French ideas which unite this whole group under the term "marchfoot" or "pied forcé," without defining the character of the changes in the metatarsals. A common factor on which all authors agree, no matter in what light they regard the process in the bones, is that of overloading the foot. Therefore we think that the term "pied forcé" (forced foot) is that which fits best of all the affection in question.

All cases of "forced foot" may be summed up in two groups. In the first, we shall place the footsoldiers, military men, sportsmen, athletes, and others who can state exactly the moment when their trouble began, and which coincided generally with a forced march, some sporting event, a long walk, or some unaccustomed overloading of the foot. The second group includes those patients whose profession or trade compels them to be on their feet for prolonged periods, such as peddlers, postmen, salesmen, medical men, etc. The patients in this group are unable to state exactly when their trouble started, and it is only in rare cases that they assign the pain in their legs to stumbling, a misstep, or slipping. The difference in the two groups explains the difference in the time at which they consult a physician, just as it explains the difference in the radiographic findings.

Clinically, the affection manifests itself by pain in the foot, which may vary from a slight discomfort in walking to a complete disability, which may require rest in bed. The pain may involve the whole foot or be localized in the involved bone, at the same time there appears swelling and infiltration of the dorsum of the foot, rarely of the sole. At this time it may be possible to palpate a thickening of the bones. Radiographically, there is shown the round or

fusiform thickening of the periosteum usually at the distal end of the metatarsal but rarely in the middle or proximal third of the bone, and a rent across the diaphysis. The question is whether these changes appear in the earliest days of the disease or whether they develop slowly. According to some texts, the radiologic changes in Deutschlender's disease do not appear until the sixth or eighth week of the affection. In "Marschfraktur," on the contrary, they can be detected in three or four weeks. This is the typical picture of the evolution of the disease.

Among the patients we have studied these changes were present in the first radiograph made, but these patients were all civilians, being in the second of our groups. They came to us after they had been on treatment of some sort without success, and often without having had any radiographic studies made. If we check over the histories of these patients, as they have been given by different authors, we shall see that in these cases also the majority of roentgenographic studies were made three or four weeks after the onset of the trouble. Such roentgenographic studies are of no assistance whatever in finding out the early osseous changes. The best opportunity of detecting the earliest changes is afforded military roentgenologists, who are in a position to make a roentgenographic study of their patients at the very onset of the affection. It was Runstrom, of the military hospital of Stockholm, who drew special attention to this point. He made roentgenographic examinations of 45 patients who had "pied de marche" in the first few days (from one to eight) after the onset of trouble. In 26 cases, the changes in the bones could be demonstrated in from one to five days. Similar findings have been reported by other authors. Momburg goes further. He radiographed the feet of all the soldiers who returned from a campaign, even though they had no complaint of foot trouble, and found in a few cases thickening of the periosteum of the second or third metatarsal. We find similar observations in the literature con-

cerning like changes in the normal foot, in cases in which the other foot is "overloaded" This fact is of great importance in the elucidation of the pathogenesis of the affection The roentgenographic changes may, therefore, appear at any time from a day to several weeks after the onset of the first clinical symptoms, and they may even in some cases precede them Since the changes seem to be identical in the two groups, the question now is whether the time of their appearance may serve to differentiate the two groups We do not think that it can We will now consider the radiographic findings

Among the various radiographic manifestations of this affection of the metatarsals, we should mention, first of all, the thickening of the periosteum as a result of the structural modification of the cortical layer and the formation of gaps or rents This spherical or fusiform localized thickening of the periosteum of the diaphysis is not at all characteristic of the affection in question We see such changes in ordinary fractures of the long bones, especially of thin bones such as the fibula or the metacarpals, and we never entertain any doubt that these changes are traumatic in origin A metatarsal bone resected by Dodd and Straus in a case of "march-foot" showed typical osseous callus (Fig 1) The changes in the cortical layer of the metatarsal, which appear as diffuse outlines of the bone at the site of the affection and which seem to extend from the medullary canal to the periphery of the bone, are in no sense anything exclusively found in Deuschländer's disease This change can be seen in the process of forming callus in ordinary fractures, and it is a manifestation of the participation of osseous tissue in the process of regeneration and development of a new osteoid tissue around the old bone tissue Unfortunately, most authors take up scarcely at all the question of the split or gap which crosses the metatarsal at the site of this process, and which may even extend into the new callus We feel that this finding should be discussed in greater detail, for, if we regard

the gap as only a fissure or as a "zone de Looser," we get no farther toward understanding the nature of the disease in question

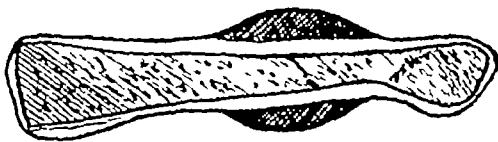


Fig 1

Let us begin with the exterior aspect The appearance of the fissure in the bone is known by every radiologist, and requires no further comment The zone of Looser, or the zone of transformation, as the author describes it, and which is seen in rickets, osteomalacia, Paget's disease, and other similar lesions, appears as a straight and clear streak or stripe with sharp edges Let us remark here that this finding is not a guarantee that we have a zone of Looser and not an ordinary fissure Schmorl, in a histologic examination of a case of Paget's disease of the tibia which was crossed by numerous clear streaks which Zalinger called typical zones of Looser, found that they were only simple fissures Now, gaps of this sort in the form of a straight streak are far from being the rule in cases of "forced foot" (*pied forcé*) We see them sometimes in the later stages of the lesion in which they cross the zone of thickening in the diaphysis One frequently sees a V-shaped fissure or a zigzag one, a finding that can hardly occur with a zone of Looser Even more contradictory is the dislocation of the osseous fragments, which is seen in cases of "*pied forcé*" Therefore, from the radiologic findings we may be dealing with a fissure in some cases, and a "zone" in others

Let us now consider the anatomic and pathologic findings as they have been reported Unfortunately, reports on these subjects are rare, and have been made by only three authors, of whom Dodd and Straus speak categorically of fracture, while Markeloff, as the result of his own study, speaks of a zone of Looser This apparent contradiction in the pathologic anatomy of the process depends on the

differences in the stage of the disease at which the observations were made, and on the static and mechanical condition of the overloaded foot. In acute overload, fissure of bone predominates in the picture. The fine line of fissure was observed several times in the first few days of the disease before the periosteal thickening. There were some cases in which it was the only radiologic sign of the affection. Behr, checking up his own material among 2,146 cases of swelling of the foot, found 877 fractures (41 per cent of the cases). Other authors report an incidence varying from 20 to 90 per cent. Osterland in all of 93 cases regarded the cause of the affection as being the osseous lesion. One must keep in mind the difficulty of determining a fissure radiologically in the absence of dislocation, more or less well marked, of the osseous fragments, and in some cases it is only by examining with a magnifying glass the fine structure of a bone radiograph that it is possible to detect the presence of a fissure. It may well be that it escapes notice in many cases. We should remember that fractures of other bones may not be detected in the roentgenogram if there is no displacement of the fragments. This is the case with fissure which may fall outside the path of the central ray, but which may show up in later roentgenograms when osteoid tissue has formed around the fracture (L. Melnikova, *Zentralbl f Chir*, 1929, 49). The attempt has been made to establish a differential symptom from the presence of this primary fracture with dislocation so that the two nosologic entities, "Marschfraktur" and "Fussgeschwulst," might be differentiated, but, by what has been said, there is no reason for this distinction. The etiology of the two conditions is the same, and the radiologic picture may show all stages of transitory forms from that of a fine, hardly perceptible fissure to that of a clear-cut displacement of the fragments. According to Runstrom, it is in those cases of primary dislocation in which the fusiform shadow is lacking (19 cases). He explains this by the fact that the blood is poured out into

the neighboring tissues, while in fractures without solution of continuity, the blood spreads out under the periosteum and thereby contributes to its rapid thickening and the formation of a shadow in the roentgenogram. This theory seems plausible to us and serves to explain some obscure facts. It then becomes easy to explain all the later manifestations of the affection, by starting with the theory of a primary fissure in the metatarsal, apparent or not, as the beginning of the clinical symptomatology of "pied forcé." The round or fusiform shadow around the diaphysis may be deciphered as a manifestation of the reaction of the periosteum and endosteum in the fracture. The moment when this callus becomes visible in the roentgenogram and the process of its ossification—as clinical traumatology teaches—are different, and depend on local factors, such as the condition of the periosteum at any given moment, the degree of separation of the fragments, the pouring out of blood, lymph, etc (Runstrom), rather than on individual peculiarities, such as age, constitutional or endocrinal factors. Once formed, the callus follows its usual course of development, that is, it reaches a certain size and then regresses, leaving at the site most affected in the periosteum a faint thickening of the cortical layer in those cases in which there is a complete return to normal.

But another train of events may take place. In the mass of newly formed callus, which is fragile and rich in osteoid tissue, there may form, as is the case in rickets or in some osteodystrophy or other, a transverse split—a zone of transformation of Looser, caused by the same phenomenon of continued overload. It is obvious that if the fissure is formed at the site of greatest pressure in the metatarsus, the callus which develops at the same point in the bone under the continued influence of the mechanical and static factors in the foot will be subjected to the same pressure. This condition will occur in every case in which the patient continues to walk with a callus already formed. As far as we have

been able to judge from what has been published, the patients with a zone of Looser in the roentgenogram were not confined to bed long enough because, according to Muller and Turner and some other authors, the thickening of the periosteum and the margins of the bone in Deuschlander's disease are the expression of the tendency of the body to fortify the threatened section of the bone, but this fortification is often insufficient, and a new fracture takes place across the zone of transformation, sometimes with dislocation of its margins. Those who hold to an osteochondropathic genesis of Deuschlander's disease consider this phenomenon as being a secondary fracture, occurring in the place which is mechanically weakened in the "zone of transformation" of the bone. Now, we have in our possession a roentgenogram which shows a zone of transformation and a fracture, in a case in which the condition came on as a result of a traumatism to the foot. The osseous changes seem to be identical in the different manifestations of "pied forcé," and the time of their appearance is of no importance as a differential symptom.

In the light of the facts established above, let us now consider the genesis of "pied forcé." The theory of the inflammatory origin of the tumefaction of the periosteum falls by itself, the theory of Deuschlander lacks confirmation. The trophoneurotic theory of Turner occupied a place by itself. Without discussing the clinical manifestations of lesion of the peroneal nerve which may produce sweating, sensory disturbances, and so on, let us state that the radiologic findings do not fit in with the hypothesis in question. Trophoneurotic processes, as they occur in other parts of the skeleton, are generally manifested by successive enlargement of bone (for example, the phalanges), which show up in the roentgenogram by coarsening of the trabecular structure, the formation of hyperostoses, infractions, etc (the tabetic foot, the syringomyelic elbows, etc), but we are unaware of any trophoneurotic changes which are limited to the

diaphysis of a single bone, and which are manifested by periosteal changes without accompanying changes in the osseous trabecular structure. Rarefaction of the metatarsus in "pied de marche" (march foot) has been observed by only Turner and his school. We have never seen it. The purely traumatic theory is refuted by the fact that there is no trauma in the majority of the cases, in spite of careful search to find it in the histories.

Special attention should be given to the theories of a statico-dynamic origin of the affection in question. In this regard, Morton has made an interesting calculation. A man of 140 English pounds, with a load of about 90 pounds, loads each one of his feet with one-tenth of an English ton, that is, about 100 kilos. To this should be added the force necessary to lift the foot from the ground during walking and to multiply this by the number of steps per minute—from 60 to 80. But considering the rarity of this affection, one must conclude that load alone is not enough to bring out this affection and that another provocative factor is needed to produce the pathologic changes in the foot. One might suppose it is some endocrine factor (Deuschlander, Muller, Greifenstein), but in this regard it is hardly necessary to more than mention that numerous observations reject this supposition. In 1925, Muller brought out the theory of the osseous insufficiency of the metatarsus according to which the affection might develop by the sole fact of the absence of parallelism between the mechano-dynamic effort and the functional faculty of the metatarsals ("pied forcé," according to our conception). According to Jansen, this supplementary factor is the spasm of the interosseous muscles acting on the hydrostatic pressure of the region of the diaphysis of the metatarsal to increase it. This leads to thickening of the periosteum, with secondary changes in bone structure and to secondary fracture. Ingenious as this theory may be, it can be accepted only by the analogy of muscular spasm of pianists, typists, etc., as by the fact of limitation of lateral passive

movement of the foot which occurs in "pied forcé" The rest of it is only a hypothesis The stiffness of the toes and the sensitiveness to pressure of the intermetatarsal muscles—symptoms on which Jansen bases his theory—might just as well be considered as secondary to the primary changes in the bones More convincing are the arguments of those authors who regard functional or structural anomalies of the foot as the cause of the changes These anomalies may be congenital or acquired Kirchner, Momburg and others emphasize an abnormal length of the second metatarsal and the jutting out of its head Others think that the cause is an enfeeblement or fatigue of the muscles of the foot which causes flat foot, with a flattening of the anterior and transverse arches so that the weight of the body is carried directly by the metatarsals, especially by the second, and to a less degree by the third and fourth

Extensive investigations of the structural and functional insufficiency of the foot have been made by J Morton These investigations were concerned primarily with the cause of metatarsalgia, described for the first time by Thomas Morton, and which has a great interest for us This author has proved that there is no concavity of the plantar arch in the region of the head of the metatarsals These latter, being loaded in walking or standing, are all in a straight line, and in the same horizontal plane (Fig 2), but the body weight is divided differently among them according to the structural and physiologic peculiarities of the foot in question Normally the longitudinal axis falls between the first and second metatarsal, nearer the first, and consequently it is this bone which is subjected to the greatest load In the triangle of weight-bearing, which is formed by the heel and the heads of the fifth and first metatarsals, it is the latter—or, rather, its sessamoids—which serves as the point of support at the internal anterior angle of the triangle Weakening of this point leads to alterations in the statics of the foot Morton established the no-

tion of a weak foot (pied debile) from a structural point of view, which is characterized by the following anatomic peculiarities (1) The excessive mobility (laxity) of the joint between the two internal cuneiforms and the navicular, resulting in a greater mobility of the first metatarsal Clinically, this stage of affairs is manifested by exaggerated amplitude of movement of the bone in passive flexion and extension, radiologically, by the enlargement of the space between the first and second cuneiform bones which seems to prolong backward the first intermetatarsal space (2) The shortening of the first metatarsal (pes atavicus), with a consequently exaggerated pronation of the foot during walking and displacement of the body weight toward the mid-line (3) A more proximal location of the sessamoids of the head of the first metatarsal so that they are behind a line which passes through the head of the second metatarsal The result of this is the same as in the case of shortening of the diaphysis of the first metatarsal (4) The broadening of the second and sometimes the third metatarsal in comparison with the others as a physiologic result of prolonged overload Dodd verified the findings of "weak foot" of Morton in 14 radiographs of "pied forcé" and found hypermobility of the first metatarsal in 12 cases, shortening of it in two cases, enlargement of the space between the first and second cuneiforms in 12 cases, broadening of the second metatarsal in 13 cases, and broadening of the internal border of the first metatarsal in all of the 14 cases In the 18 roentgenograms we have found shortening of the first metatarsal in five cases, displacement of the sessamoids in 11 cases, less definite displacement in four cases, thickening of the internal border of the first metatarsal in eight cases, less definite thickening in six cases, definite enlargement of the space between the first and second cuneiforms in 14 cases, questionable enlargement in two cases thickening of the diaphysis of the second metatarsal in seven cases, and thickening of the diaphysis of the third metatarsal in three cases

We would like to call attention to a fact hardly mentioned in the work of Jansen which may play a rôle in the genesis of the changes in the metatarsals in "pied forcé," that is, the division of the load at the moment the heel is lifted from the ground when all the weight of the body is carried on the line of the heads of the metatarsals and on the base of the toes. As can be seen in the diagram of Morton (Fig 2), this line starts on the sessamoids of the first metatarsal and passes to the head of the fifth. In case of shortening of the first metatarsal and backward displacement of the sessamoids, the internal end of this axis is also displaced backward and crosses the diaphysis of the metatarsals before their middle third, that is to say, at just the point of predilection of the formation of fissures and of thickening of the periosteum in cases of "pied forcé." There results an appearance of elongation of the metatarsals, especially of the second and third, and consequently the increase of their overload in walking.

In résumé, we have come to the conclusion that the malady in question is the result of overloading the foot in individuals whose foot is functionally and anatomically weakened. The anatomic changes undoubtedly give rise to the clinical symptoms. In certain cases, because the foot adapts itself or because of extreme overload, these changes may evoke no clinical symptoms whatever, in other cases the subjective symptoms and objective findings may appear perhaps as the result of excessive demands on the function of the foot even though this demand be a very short one, as well as after a prolonged overloading of the foot and in cases in which the necessary rest has been neglected. In this case it is, to use an expression of Dodd, "an autotraumatic complication of a subacute affection." According to the views of Osterland, the fissure in the bone is the result of an internal regrouping of the atoms in the osseous trabecular structure and the formation of "a line or a zone of slipping" which is the forerunner of the formation of a fracture. The phenomena

of regrouping which take place in the crystalline structure of the bone are identical to those which are observed in stressed metal as was observed by Henschen by

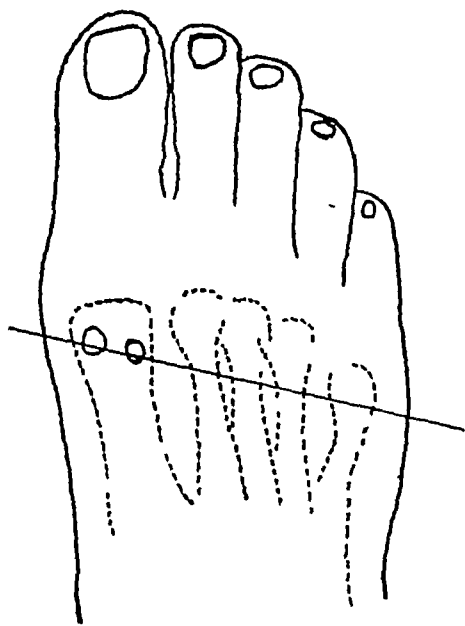


Fig 2

micro-radiologic analysis. The other changes which we have described above consist in the reactionary expansion, or of compensation of the corresponding metatarsals. In place of a round or fusiform shadow, characteristic of "pied forcé," we have a widening, which may extend through the whole diaphysis, only reserving the head and base of the bone. This localization corresponds to the point of insertion of the interosseous muscles as indicated by Jansen. One might conclude that their hyperfunction would result in an excessive irritation and a condensation of the periosteum, as we have observed on a few occasions at the point of insertion of the tendons in bone.

A few words about the age of the patients might be in order. The majority of authors speak of the second and third decades, but rarely of the fourth. Turner published a case of "pied de marche" in a man of 60 years. It is generally supposed that early age, with the suppleness and power

of adaptation which the bones and tendons have, is less subject to this affection. Nevertheless, the ages of 16 and 17 figure largely in the reports of most authors (Reckand). We have seen a typical case of acute "forced foot" in a little girl of ten years.

The affection described under the names "pied de marche," "fracture de marche," "Deutschländer's disease," seems to be the least justifiable of all. "Pied surchargé" (overloaded foot) seems to be the term which best fits the malady in question. The analysis of each radiologic symptom, taken by itself, shows that the fissure and the fusiform shadow which surrounds it are the most constant and characteristic symptoms. Moreover, some anatomic alterations may precede the subjective appreciation of the trouble and thereby emphasize the subchronic nature of the process. Of all the theories which have been proposed—inflammatory, traumatic, neurogenic, or functional insufficiency of the foot—it is the latter which deserves greatest attention. Starting with the findings of Morton and Jansen, we come to the conclusion that there are two classes of alterations in the metatarsals as shown radiographically, among the first there are the symptoms of "weak foot," described by Morton, to which there should be added the diffuse thickening of the metatarsal diaphysis. It is possible that hyperfunction of the interosseous muscles plays a rôle in the thickening of the periosteum. The second class of changes is the spherical or fusiform thickening limited to the middle third of the metatarsal. This shadow is of a typical periosteal callus, developing

around a primary fissure of bone. The appearance of the fissure is the result of a regrouping of the internal atomic crystalline structure as was shown by Henschen. The cause of the fissure of the bone is the displacement of the weight of the body from the head of the metatarsals toward the mid-line, favored by the anatomic conditions and the structure of "weak foot." Clinically, the affection may have an acute onset, in these cases the radiograph may show osseous changes in the very first days. In other cases, the lesion develops more slowly, so that there is no fissure in the first radiographs, it is the bony callus, which forms more slowly that becomes the first symptom of the affection to be seen radiographically. "Pied forcé" has no relationship to either age or sex.

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THE RELATION BETWEEN AGE AND RADIOSENSITIVITY OF *DROSOPHILA* EGGS

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MANY of the fundamental problems regarding the effects of short radiations on living cells can best be solved by the study of the reactions which these rays produce on small biologic test objects. The effectiveness of different wave lengths, the effect of divided doses, of equal doses delivered at high and low intensities, the changes in the sensitivity of cells during mitosis, and the measurement of α - and gamma-ray doses are questions to which the reactions of comparatively simple organisms can often give clear answers. For testing quantitative effects of radiations, the eggs of the fruit fly *Drosophila* are undoubtedly superior to all other test objects. The flies can easily be obtained and reared, and they lay eggs throughout the year in large quantities. The eggs are so small that radiations produced at ordinary voltages suffer practically no differential absorption, the entire egg is uniformly irradiated. Finally, the proportion of eggs that survive or are killed by a definite dose of any wave length is remarkably constant if the experiments are always performed in precisely the same way. However, if the technic of collection and exposure is altered, the quantitative results differ. The reason for this lies in the fact that the eggs develop rapidly, and during this process their sensitiveness to radiations changes greatly. If the samples that are exposed are not of the same average age, their response to equal doses will be very different. The object of the present experiments is to determine as precisely as possible the changes in the sensitivity of these eggs from the moment they are laid, shortly after insemination, until they are about five hours old, at which time they have already passed the stage when the gut is formed.

The methods of collection and irradiation have already been described in detail (2, 4,

and 7). Flies from a pure culture of wild *Drosophila*, inbred for many generations, are transferred to clean milk bottles and given special food consisting of about twenty parts of fermented banana and one part of Fleischmann's yeast. This is rubbed through a sieve and thus thoroughly mixed, and spread thin on pieces of black filter paper (Scheicher and Schüll, No 551) which have been wetted with banana juice. The bottles are now put in an incubator at 26° C and left undisturbed for two hours, at the end of which time many eggs will have been laid. These are now transferred to another piece of wet filter paper by means of a small camel's hair brush, and crowded together in a single layer. They are then placed in a moist chamber from which any stray flies are excluded, to prevent the possible addition of a crop of younger eggs. If it is necessary to carry them some distance to the α -ray machine, they should remain in this chamber until the time of exposure. Precisely one hour after the end of the laying period they are irradiated, all of the slips with eggs being exposed simultaneously, one after another being withdrawn when each has received the desired dose. In order to avoid the effect of scattered radiation, the slips are supported on gauze held in a light wooden frame of such dimensions that the wood lies outside of the path of the direct beam. This is a necessary precaution, for the eggs are extremely sensitive to small amounts of soft scattered rays. During exposure, the gauze under the eggs is kept moist with banana juice. Both before and after irradiation, the intensity of the beam is carefully measured by a thimble chamber previously calibrated at the same voltage and filtration with a standard open ionization chamber. The maximum exposure should not be more than 25 minutes, and the intensity, not less

TABLE I

Age of eggs	50% survival dose	Relative sensitivity	"Standard Deviation"
Standard sample	187 r	100 0%	
0 min	290	64 5	± 5.61
30 "	260	71 6	4.52
60 "	247	75 7	7.02
90 "	163	114 7	2.22
95 "	174	107 5	
120 "	183	102 0	3.54
140 "	229	81 5	
150 "	366	50 8	4.15
180 "	861	21 7	1.44
210 "	675	27 7	1.94
270 "	861	21 7	1.62
330 "	1 044	17 9	0.73

TABLE II — SENSITIVITY OF TWO SUCCESSIVE COLLECTIONS OF EGGS

Dose 213 r in 10 min			
First collection	Dose from curve	Second collection	Dose from curve
47 1%	196 r	56 4%	171 r
44 0	206	58 1	167
35 7	233	67 4	145
46 3	198	64 2	152
41 4	214	61 8	158
35 9	233	56 9	170
39 9	219	61 9	158
40 5	217	55 9	173
Av 41 4%	214 r	60 3%	162 r

than 5 r/min. Higher intensities, obtained by varying the amperage and distance, are preferable since they permit comparatively brief exposures. These precautions must be taken if precise results are desired.

The exposed samples are now kept at room temperature in a moist chamber. Under these conditions they hatch out in from 36 to 48 hours. However, some flies do not lay their eggs immediately after insemination but retain them for some time. Such eggs are already well advanced in development when they are deposited; they are highly resistant to x-rays, and they hatch out many hours before the others. If the samples are examined on the day following the exposure, these eggs that have already hatched can be counted. Their number is subtracted from the total, which is determined the next day. The living eggs can easily be distinguished, for they

are represented by the empty shells left behind by the larvæ when they emerge. These shells are wrinkled bags of parchment-like material, and are wholly different in appearance from the dead eggs, which remain plump. Eggs which are treated in this way constitute what will be called "standard samples." The proportion of such eggs that survive after receiving measured doses serves as a standard with which to compare the behavior of other eggs which, because of their different age and stage of development, differ also in sensitivity.

When standard samples are exposed to a definite dose, measured in roentgens, a definite percentage of the individuals survives and hatches out as larvæ. A record of eight such tests is shown in Table II under the caption "First collection." The average percentage hatching is 41.4, the maximum deviation of a single test being 5.7 per cent, and the minimum, 0.0 per cent. After many such tests have been made with doses ranging from 50 to 400 r, the data are plotted on co-ordinate paper, the proportion of survivors being shown on the ordinates, and the doses, on the abscissas. These points fall along the smooth curve shown in Figure 1. By means of this curve, the doses needed to produce any desired survival rate can readily be determined.

Conversely, the curve can be used to measure dosage. For, if a definite dose results in a fairly definite proportion of survivals, then that proportion indicates the number of roentgens which were delivered. The application of this method is shown in Table II in the column labeled "Dose from curve." Here the number of roentgens corresponding to each percentage of survivals is taken from the curve. The average of all the individual doses is 214 r, measured by the dosimeter; the dose was 213 r. So close a correspondence is not often obtained; on the other hand, a difference greater than 5 per cent is rarely found.

Now, it is obvious that this method is of value only so long as the different standard samples maintain a constant average sensi-

tivity The term "average" is used because such samples are composed of eggs which differ from each other in age by about two hours, that is, by the length of the collection period They differ also in sensitivity But experiments conducted during the past few years have demonstrated that the response of heterogeneous populations of this kind is indeed constant, provided that the method of collection and irradiation is not changed If the percentages of survivors in a number of samples which have been given the same dose differ widely from each other, the experimental technic has been faulty

The relative sensitivity of *Drosophila* eggs of different ages has already been studied by Henshaw (3) In his experiments he used samples of eggs obtained during a two-hour collection period, exposing them at various intervals thereafter It is evident that by this method only the average sensitivity can be found, the susceptibility of eggs of definite ages will not be revealed The relative sensitivity is determined by comparing the doses needed to kill a certain proportion of the eggs in samples of different ages He finds, in general, that susceptibility increases somewhat as the eggs develop, the maximum being at the age of two hours It then falls abruptly during the next hour, and subsequently rises and falls again to a small extent The actual amount of these changes is uncertain because the results of his three experiments do not agree satisfactorily with each other

The relative susceptibility of eggs of definite ages and stages of development can be determined precisely by using samples composed of individuals all of which are laid at the same moment These are very difficult to obtain However, if the eggs are collected during a thirty-minute period instead of the usual two hours, they will be of nearly the same age Usually the flies in a mass culture do not lay their eggs at once when they have received their special food, but begin about fifteen minutes later Thus the eggs, at the end of a thirty-minute period of collection, differ in age from

each other by not more than fifteen minutes, practically all of them are in the two-cell stage, few having divided more than once They constitute a fairly homogeneous sample The number laid in this short time is not large but is sufficient for experimental purposes During collection, the cultures are kept at 26° C in an incubator Subsequently, the eggs are properly arranged on slips of wet filter paper, and then returned to the incubator, where they remain until the time of exposure Samples have been irradiated at thirty-minute intervals and at some intermediate points, commencing directly after the end of the laying period The age of the eggs is reckoned from the end of this period In all of these experiments, the x-rays were excited at 120 K V, the tube current being 5 ma, the filter consisted of 0.25 mm copper and 1.0 mm aluminum The doses were so adjusted as to result in survival percentages ranging from 85 to 30 per cent

In Figure 1 are shown the results of experiments in which the eggs were irradiated at intervals of one hour, beginning thirty minutes after the end of the collection period The remaining data obtained from tests made at the other time intervals have been omitted in order to simplify the figure, they appear in another form in Table I and Figure 2 The points determining the course of each curve are, in many instances, the average of several separate tests in which the same doses were given on different days For comparison, the curve showing the reaction of the standard sample has been added The latter is based on data obtained from a very large number of experiments carried on during the past six years

When these curves were fitted to each set of data, it was found that they were all practically alike, differing from each other and from that of the standard sample only in the scale of their abscissas If, by changing this scale, they are made to coincide at any point, they coincide also at all other points Thus the sensitivity of the eggs and their stage of development does not

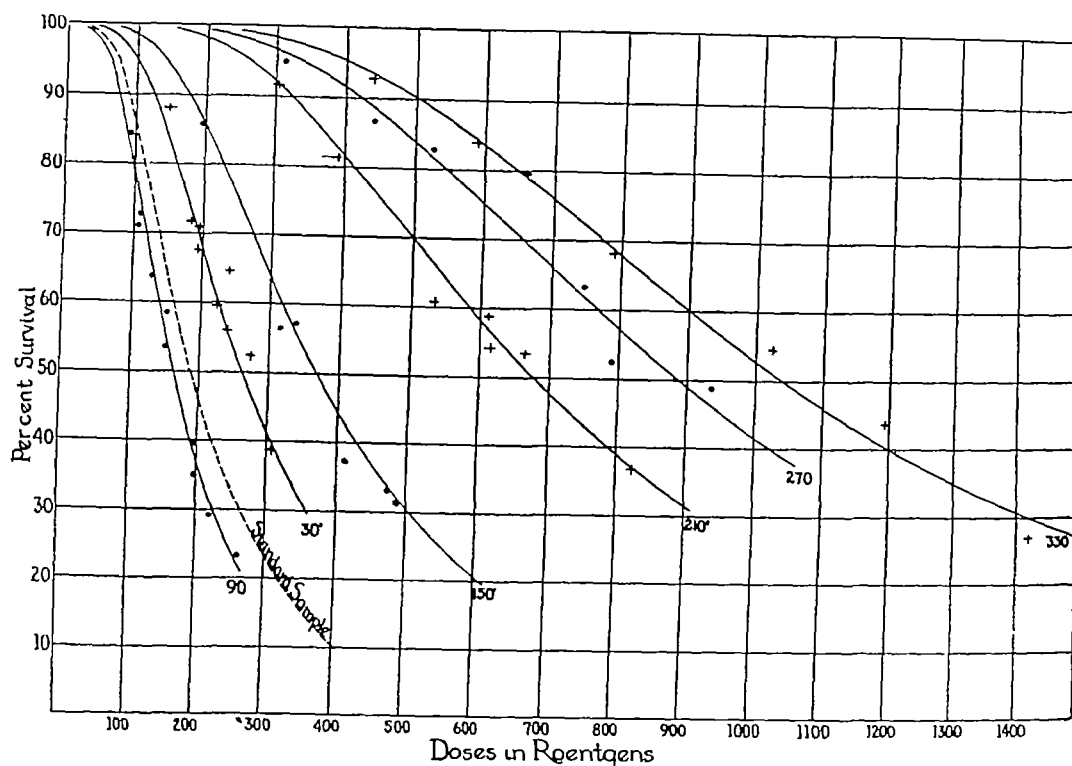


Fig 1 Survival curves of eggs irradiated at different ages, and of the standard sample, whose average age is approximately 120 minutes

affect the fundamental nature of the curve. This is true whether the curves express the reaction of samples of eggs composed of individuals all of which are in the same stage of development, or of samples made up of individuals which differ considerably in age and sensitivity. In this respect they are wholly unlike those figured by Henshaw (2), who finds that his survival curves for eggs of different ages pursue irregular courses, and cross each other in some instances.

The wide differences in sensitivity between old and young eggs are at once apparent. The 50 per cent survival dose for eggs that are 90 minutes old is 163 r, for eggs that are 330 minutes old, it is 1044 r. The former are thus more than six times as susceptible as the latter. This dose for eggs of the different ages tested is given in the second column of Table I. It is apparent that the number of roentgens needed to kill half of the eggs grows progressively smaller as the age increases up to 90 minutes, thereafter it increases steadily

except for a noticeable decrease in the case of eggs that are 210 minutes old. The figures in the third column of Table I show the relative sensitivity, the sensitivity of the standard sample being 100 per cent. They are obtained by dividing the dose in roentgens needed to kill half of the eggs in the standard sample by that required to kill the same proportion of eggs of each age.

The points which determine the course of the different curves shown in Figure 1 do not always lie close to the curves but are found at various distances above or below them. The departures in the case of the 90-minute eggs are very small, for the 30-minute eggs they are comparatively large. It is important that the amount of divergence from the average be measured in order that the degree of consistency of the results can be determined. The Standard Deviation, shown in the fourth column of Table I, is such a measure. For the 90-minute eggs it is ± 2.22 per cent. This means that approximately two-thirds of all the tests depart from the expected value by less

than this amount. These very consistent results are not found in tests with the 60-minute eggs. The Standard Deviation of much more widely

differ considerably in sensitiveness. The results of repeated tests, therefore, vary

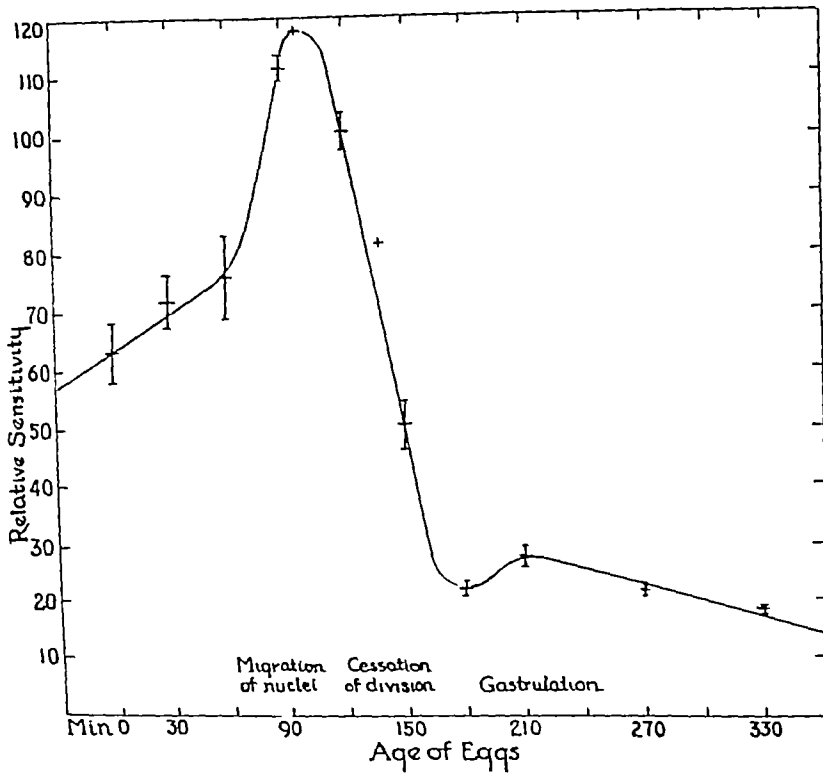


Fig 2 The relative sensitivity of eggs of different ages. The long vertical lines drawn through the short horizontal lines which indicate the sensitivity of eggs at each age show the magnitude of the Standard Deviation for the observations made at these points.

the latter is ± 7.02 per cent. In Figure 2, these values are shown graphically by the length of the vertical lines drawn through the points which mark the relative sensitivity of the eggs of each age. When less than ten separate tests were made on eggs of a definite age, their Standard Deviation was not calculated. The degree of consistency in the results of repeated tests on eggs of each age is evidently correlated with the rate of change in the relative susceptibility and with the rate of mitotic activity. When the sensitivity changes slowly, as it does in eggs that are four hours old, the different samples are about equally susceptible, and respond about equally to the same dose. But the reverse is true of 60-minute eggs. The different samples, because of the method of collection, are not of precisely the same age, and, therefore,

The changes in susceptibility during the first three hours of development are correlated with definite embryonic conditions. Shortly after the eggs are laid, nuclear division begins and continues at the rate of about one mitosis every ten minutes, for nine divisions. The nuclei thus formed migrate to the periphery, where they become surrounded by islands of protoplasm. During this period, the sensitivity increases rapidly, reaching a maximum about 100 minutes after insemination. At this time the first evidence of differentiation appears. This consists in the formation, at the posterior end of the egg, of the pole cells, which later give rise to germinal epithelium. The eggs are now also highly susceptible to mechanical manipulation, whereas before this time and afterward, they are not. The next developmental stage con-

sists in the formation of cell walls between the nuclei, which at this time have ceased to divide. With this cessation of mitotic activity, the sensitivity of the eggs falls abruptly to a low point which is reached about 180 minutes after insemination. Subsequently cell division is resumed and invagination occurs. This stage is associated with a small increase in susceptibility. Thereafter, the embryo grows more and more resistant.

Studies on the effect of x-rays on other stages in the life cycle of *Drosophila* show that susceptibility is greatest when physiologic and morphologic changes are in progress. The unripe egg is comparatively resistant (9 and 12), but its sensitiveness increases during the period of maturation, fertilization, and early cleavage, reaching a maximum at the moment when the embryonic cells begin to differentiate. It increases again during gastrulation, and once more when the pupa undergoes reorganization. In the intervals between these periods it decreases steadily. The adult fly is very resistant. Mavor (5) finds that the dose which kills half of the adults in a sample is eighty times as great as that needed to kill half of the embryos. Thus, the statement that embryonic and immature cells are more sensitive than adult cells is true in general, but the most susceptible cells are those that are undergoing a transformation from a less to a more specialized condition.

The average age of eggs composing the standard sample is about 120 minutes, but some individuals may be as young as 60 minutes, and some as old as 180 minutes. There are few of these, however, but it is remarkable that the average sensitivity of such samples should remain constant from year to year. Obviously, the egg-laying rhythm must always be about the same, if the method of collection is not changed. But occasionally this rhythm is altered, with the result that the sensitivity of the sample is lower than expected. This may happen if, at the end of one period of collection, the flies are given fresh food and induced to lay more eggs. Since the pro-

cess of removing the first food and inserting the second does not greatly disturb them, they often begin to lay actively at once, and then after a varying time, practically cease, this behavior I have frequently observed. The result is that at the time of irradiation the average age of such eggs is greater than that of the eggs in the first sample in which egg production was fairly continuous. The difference in sensitivity between two such samples is illustrated in the experiments recorded in Table II. In these tests, the flies were kept at room temperature on the laboratory table where their behavior could be watched. The records of samples from the different bottles are shown separately. The dose of 213 r, given to both sets of eggs, should result in a survival rate of 41.7 per cent, as shown by the curve. In the first test, the scores of the different samples vary from 35.6 to 47.1 per cent, the average being 41.4 per cent, that is, practically the expected ratio. The record of the second test, made immediately after the first, shows that the average sensitivity is much lower. The survival rate of 60.3 per cent corresponds to a dose of 162 r. This figure, divided by the actual dose, gives the relative sensitivity of the samples. The average is 76 per cent of the expected value. When the same flies were tested on the following day, the first collection of eggs showed the normal degree of susceptibility. Since this change in the rhythm of egg-laying often occurs under these circumstances, it is evident that in carrying out experiments with *Drosophila* eggs, the flies should not be induced to lay a second lot of eggs immediately after they have produced the first.

DISCUSSION

The sigmoid shape of the survival curve shown in Figure 1 indicates that there is a wide variation in susceptibility to x-rays among the eggs used in a single experiment. Some that are highly sensitive die after receiving a dose as small as 50 roentgens, others which are resistant remain alive after an exposure of ten times that amount,

while the sensitivity of the majority, which succumb to doses of intermediate magnitudes, lies between these two extremes. Similar survival curves which illustrate the fact of variation are obtained in experiments on the rate of hemolysis of red blood cells in water, on the number of bacteria or spores killed by phenol, and on the insecticidal action of various chemicals. Even though the biologic material is selected with greatest care to insure uniformity, the individuals always show morphologic and physiologic differences, which are responsible for this variation in sensitivity to toxic agents.

The survival curve is, therefore, an expression of this variability in the susceptibility among the eggs composing each sample. Since the curves representing the survival rate of eggs of different ages are fundamentally alike, it may be inferred that, in the samples which were used, the proportion of individuals which were more sensitive or less sensitive than the average remains practically the same. The youngest eggs, irradiated when they are in the one- or two-cell stage, show the same degree of variability as do the oldest eggs, exposed when they are already past the gastrula stage.

Henshaw (2) arrives at a very different conclusion. He finds that the survival curves of eggs of various ages differ from each other in a marked degree. Some resemble those shown in Figure 1, while others are irregular, having "a level part somewhere in the middle region." The latter characteristic is due, he believes, to the fact that the samples contain eggs of different ages. In view of the experimental results reported here, this conclusion cannot be correct. More probably, during the period of collection, the egg-laying rhythm of the flies in some of his cultures was altered in the way already described, the effect being that among the several lots of eggs exposed simultaneously in a single experiment, some were far more resistant than others. The result of such a test must necessarily be misleading.

The use of the survival curve as a bio-

logic method for measuring x-ray dosage has already been briefly described. The precision of this method is surprisingly great if due attention is paid to details of technique. However, it is of value only if the course of the curve is constant, that is, if the sensitivity of the standard sample does not change. The experience of several years has proved that in this respect the eggs are very uniform. This is true when different strains of wild *Drosophila* are used for stock. I have tested flies obtained from New York, Florida, Oregon, and from Sweden, and have found no appreciable difference in their reaction to equal doses. In Germany, Jungling and Langendorff (4) have carried on similar experiments with native *Drosophila*, and report that the survival curve is "practically identical" with that of the standard sample shown in Figure 1, the half killing dose being 190 roentgens. The small differences found at some other points are within the range of experimental error. In all probability, eggs from any stock of these wild flies will be found to be equally sensitive. If, therefore, a stock is accidentally lost, a new one can be substituted even in the midst of a series of experiments.

It should be emphasized that the sensitivity of the standard sample remains constant only when the eggs are collected and irradiated according to the technique here described. If the latter is modified by changing the length of the collection period, or the time elapsing between the end of that period and the moment of exposure, the average sensitivity will also be changed. But it has been shown that the mortality curves based on experiments carried on under these different conditions are precisely like that of the standard sample, except in their scale of abscissas. They can, therefore, be used in the same way as the standard curve in the measurement of dosage. Not all would be equally useful for this purpose. Eggs exposed when less than 90 minutes old are changing so rapidly in sensitivity that the results obtained from them will vary widely. Older eggs are more satisfactory. Whatever kind of sample is

used, the technic of collection and irradiation should be exactly the same in every test

The eggs are equally sensitive to x-ray beams of widely different intensities. This has been clearly shown by Sievert and Forssberg (10 and 11), who tested the reaction to beams ranging in intensity between 28 and 4,690 r/min. When delivered at rates lower than 5 r/min, the rays are only slightly injurious, probably because the eggs during the necessarily long exposures have a chance to recover in part. Under such conditions, the survival curve is very different from the normal, the most susceptible eggs are quickly killed, while the resistant individuals remain alive even after large doses. On the other hand, doses delivered at very high intensities kill a larger proportion of eggs than similar doses of moderate intensity, but equal doses, delivered at intensities usually available, produce practically equal quantitative results. The absence of a *time factor* is a point in favor of this biologic material, since no correction for it need be made in the experimental results.

Finally, the course of the curve is constant, regardless of the wave length of the incident beam (6 and 8). Equal doses of x-rays generated at potentials ranging from 12 to 550 K V kill equal proportions of these eggs. This is also the conclusion of Glocker and his collaborators (1), who used homogeneous beams of 0.54 and 1.54 Å, and of Henshaw (3), who concludes that the effects produced by 165 and 700 K V x-rays are substantially the same. When gamma rays are used, the survival curve showing the relation between dosage in millicurie-hours and the percentage of eggs surviving has precisely the same shape as the x-ray curve. This observation has recently been confirmed (4). Indeed, any other result could not be expected since the curve is an expression of the normal vari-

ability in sensitiveness of these eggs to radiations.

The evidence presented here demonstrates that *Drosophila* eggs are especially useful in studying the effectiveness of x-rays. Their sensitivity is the same even though they are obtained from stocks derived from widely separated parts of the world. However, the sensitivity changes in a definite way with their age and stage of development. For this reason the experimental conditions must be most carefully regulated.

SUMMARY

The radiosensitivity of *Drosophila* eggs increases rapidly during the early stages of nuclear division, attaining a maximum when the embryo shows the first sign of differentiation. Thereafter, it falls abruptly, but rises a little during the period of gastrulation. It then declines slowly.

The course of the survival curves for eggs of different sensitivities and stages of development remains constant. It is an expression of the variation in sensitiveness of the individual eggs composing the samples.

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INTRAVENOUS UROGRAPHY IN INJURIES TO THE GENITO-URINARY TRACT

By WILLIAM J CORCORAN, M D, *Scranton, Penna*

THE introduction of opaque substances into the genito-urinary tract has revolutionized the entire field of urology. While the injection of sodium iodide by the retrograde method has been a distinct advance in urologic diagnosis, the intravenous administration of substances excreted by the kidneys has been a greater one as far as injuries are concerned. Recently a

The retrograde method gives no indication as to the function of either kidney except indirectly, through the demonstration of abnormality, whereby disturbance in function is presumed. The intravenous method gives one an idea of the excretory power of each kidney at least in so far as that particular substance is concerned.

The writer has just recently obtained



Fig 1 Roentgenogram made 24 hours after the injury



Fig 2 Roentgenogram made five minutes after the intravenous injection of 15 c c of Neo-10pax

substance, Hippuran (sodium-ortho-iodo hippurate) has been introduced which can be administered by mouth. Neither method will probably ever supplant the other in a universal way. In some cases the intravenous and retrograde methods will be employed, in others, the retrograde and the oral administration will be used.

some hippuran and has not used it, except in one case. It was used in a case in which a diagnosis of tuberculosis of the kidney was made and found at operation to be correct. Many diagnoses in the genito-urinary tract will be made, accepted, and the patients operated upon, with only one method of administering the opaque substance being employed. In some cases

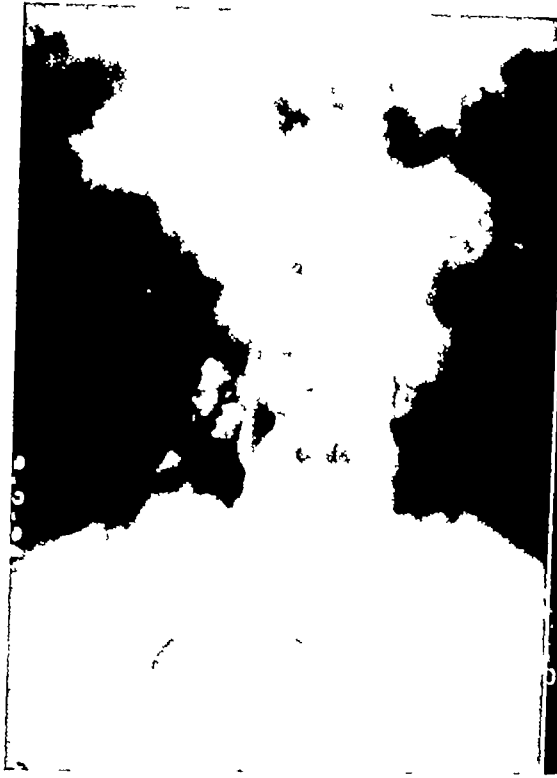


Fig 3 Roentgenogram made 15 minutes after Figure 2



Fig 4 Roentgenogram made 10 minutes after Figure 3

this will be sufficient but in many others it will not. The writer has seen a case in which the introduction of neo-skiodan showed a poorly functioning kidney, the retrograde method was employed and a perfectly normal pelvis, calices, and ureter were seen. The intravenous method was again employed with much better results than the first one.

One reason why the retrograde method will not be used in many cases in which it should be, is that so few can do it. Another reason reacting against it is the apprehension on the part of the patient.

Referring physicians in many instances do not know the difference between the different methods, and will be content to accept what information is given them by the roentgenologist after only one method is used.

Different ways of arriving at the same conclusion are always accompanied by considerable controversy. While several methods may be equally good, some individu-

als claim that some one method is the one *par excellence* and that the others are not so good. witness the different claims of roentgenologists for and against the intravenous and oral methods of cholecystography. One individual may obtain remarkable results with one method and find that his percentage of error is much higher with the other. The reason lies in the fact that he is used to the one and not to the other. There is also the added fact that he may not carry out the other method in as exact detail as one who obtains almost perfect results with it. It is only natural that one will and should adhere to the method which gives him the best results.

In discussing the question of investigation of injury to the genito-urinary tract the writer believes that the intravenous method of administration will be the one most extensively used. The reasons are several and obvious. In the first place, the patient is suffering more or less from shock, and vomiting usually occurs. The



Fig 5 Roentgenogram made 30 minutes after Figure 4

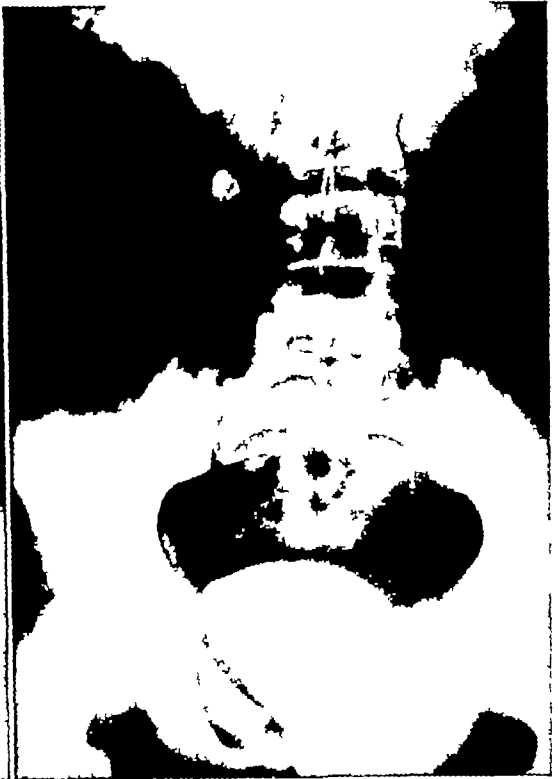


Fig 6 Roentgenogram made 15 minutes after Figure 5

former will react against the retrograde method and the latter against the oral. However, there are other reasons why the retrograde method should not be used in injury, especially in the upper genito-urinary tract.

Still, when injury to the bladder only is suspected, it is very easy and simple to inject some sodium iodide solution through the urethra and find out in a very short time whether or not a ruptured bladder exists. The writer had one such case in which the patient recovered without operation.

The intravenous method of administration to the genito-urinary tract enables one to obtain roentgenograms in five minutes; this is not possible at present with the oral administration of hippuran.

Injuries to the genito-urinary tract are often accompanied by ileus; this is another contra-indication to the oral method. The element of time is always a great factor in injuries, especially when they are internal.

The writer has seen thorotrast administered in injuries to the genito-urinary tract, but the wisdom of injecting that substance into the blood stream is questioned so strongly as to prohibit the use of it in its present form. There is a law in Austria forbidding its use anywhere in the country.

In examining patients with suspected injuries to the genito-urinary tract, it is important to remember that a certain condition may have been present prior to injury. This part of the history deserves special consideration. It cannot be presumed, although it is natural, that a person is absolutely normal up to the time of an injury; witness the conditions found in the spines examined for injury. These pre-existing pathologic entities may be aggravated by, and may have participated in, the injury, but beyond any question of doubt they existed before the trauma took place.

McKenna (1) has recently pointed out in a very excellent article the value of intravenous urography in injuries to the



Fig 7 Gross specimen

genito-urinary tract. He reports several cases of ruptured kidney diagnosed before and confirmed at operation.

The following case is reported by the writer.

A boy, aged 15, was sleighriding, March 1, 1934, when he collided with a parked automobile. He did not appear to be injured to any great extent, but on arriving at home a physician was summoned. There were no marks on the body except a slight abrasion over the left iliac crest. The boy was treated expectantly until it was seen that blood appeared in the urine. On the day following the injury he was

taken to St. Joseph's Hospital, Carbondale, Pa., where an x-ray examination of the genito-urinary tract was requested.

The patient vomited several times, was very tender and rigid over the left side of the abdomen and pelvis. One of the physicians suspected a ruptured bladder—the tenderness over the left kidney was very moderate—notwithstanding the fact that it was twenty-four hours since the injury. Roentgenograms were made of the genito-urinary tract before the administration of any opaque material. These showed (Fig 1) a considerable amount of gas in the bowel and neither kidney was visualized. A cluster of dense shadows was seen on the right side opposite the fourth lumbar vertebra. The line of the psoas muscle, however, could be plainly seen in its normal appearance on the right side; on the left side, it was distorted and pushed toward the mid-line.

Fifteen c.c. of neo-iopax was administered intravenously and roentgenograms made in five minutes (Fig 2). Here we see the pelvis and calices of the right kidney and the right ureter. Note the distinction of the psoas muscle line on the right side, especially opposite the first and second lumbar vertebrae. The dense shadows previously described opposite the fourth lumbar vertebra apparently have no connection with the genito-urinary tract and were interpreted as being calcified glands in the abdomen. Note the obscured psoas muscle line on the left side, with no visualization of the left kidney or ureter.

Roentgenograms made at the end of twenty minutes (Fig 3) showed the substance of the right kidney, with pelvis, calices, and ureter well outlined. Also note the difference in appearance of each psoas muscle line. The left kidney area is clearer and very irregularly outlined—no evidence of the left ureter.

At the end of thirty minutes (Fig 4) practically the same appearance prevailed. Roentgenograms at the end of sixty minutes (Fig 5) showed the right kidney, ureter, bladder, and the pelvic portion of the left ureter—thus latter, I believe, was due

to back pressure from the bladder and not to any material which came from above on the same side. The bladder was not ruptured.

It was decided to wait until the bladder was quite distended in order to convince one of the physicians that it was not ruptured. Roentgenograms at seventy-five minutes (Fig 6) showed the right kidney, part of the ureter, the bladder, and the pelvic portion of the left ureter, the latter much less distinct, however, than in the previous roentgenogram, and with no evidence of the ureter above the brim of the pelvis.

X-ray Findings —Ruptured left kidney

The patient was given pre-operative treatment and operated upon the following morning by Dr Thomas P Martin, assisted by Dr Conarton, Dr Kaufman, and Dr La Conna. This was approximately forty hours after the injury (March 3, 1934). The patient's temperature was 100.6° F, his pulse was 92, respirations, 24, hemoglobin, 80, red blood cells, 4,080,000, white blood cells, 18,500.

Urine —Color, bloody, reaction, alkali-

line, sugar, negative, sp gr, 1.035, albumen + + + +

Microscopic Examination —Entire field contained red blood cells.

At operation the entire perinephric space contained blood and clots, the kidney was severely lacerated, being almost completely severed in several places (Fig 7), and the left ureter was partially torn at its pelvic connection. The condition obviously necessitated removal. Drains, etc., were inserted. The boy had a very stormy time for about a week, however, he made a satisfactory recovery, and was discharged from the hospital March 16, 1934. The urine gradually cleared up so that, on discharge, it was practically normal.

This case is presented as one more addition to the list of injuries of the genito-urinary tract, already recorded, which were accurately diagnosed before operation.

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EDITORIAL

LEON J MENVILLE, M.D., *Editor*

HOWARD P DOUB, M.D., *Associate Editor*

THE LABORATORY—ITS GENESIS

The radiologist has been confronted with two obsessions, one the appellation of *laboratory*, the other the expression of *x-ray picture*. Both seemed reproachful. Of course, from the psychologic aspect of the radiologist these terms denote abject simplicity to such an extent that their repeated use seems to exert a derogatory influence on the minds of the lay people.

How frequently this was done, intentionally or unwittingly, is of no consequence—the end-results were the same.

One wonders how the designation of “laboratory” came to be applied to the office or the department of a radiologist. It was only a few years ago that the x-rays were discovered and they were discovered in a physics laboratory, is this the genesis of the term? Or, was it immediately applied because of the apparatus used, because of mechanization? If so, the use of an ophthalmoscope immediately places the office of an ophthalmologist in the category of a laboratory. Likewise, the use of a hammer, chisel, and saw, or a needle, thread, and scissors, by a surgeon, would classify the surgical department as a laboratory.

Because of peculiar circumstances that seemed to call for repeated clarification, the writer communicated with Dr H J Holmquest, then Secretary of the Council on Physical Therapy of the American Medical Association, for assistance, which was generously given. He propounded the issue to the different members of the Council with the following responses:

G M MacKee, M.D. “Regarding the definition of the word *laboratory* as used by roentgenologists, I have given this some thought and I have been unable to think of a satisfactory definition. I wonder if it is necessary or even advisable to have such a definition. The word ‘laboratory’ is being used by roentgenologists instead of the word ‘office,’ and if it is continued to be used, it will undoubtedly become a standard word with a standard meaning or a reasonably definite meaning.

“As generally used in medicine, the word ‘laboratory’ indicates a place where experimental work is carried on or where diagnostic work is done or where preparations are made to be used therapeutically in another place. So far as I know, the word ‘laboratory’ has not been used for a place where patients are actually treated. According to this definition, it would be permissible to use the word ‘laboratory’ for a place where x-ray diagnostic work is done.

“There does not seem to be any real necessity for the word ‘laboratory.’ In an institution, the word ‘department’ would be used, and in private use, the word ‘office’ would seem to suffice. In this event, the word ‘laboratory’ would apply only to a place where experimental work is done with x-rays or radium.

“For obvious reasons, the word ‘studio’ is objectionable. It is probable that the word ‘laboratory’ will become a fixture and, if so, it might be well to indicate whether it is a diagnostic laboratory or a therapeutic laboratory and, of course, whether it is a radium laboratory or x-ray laboratory or both.”

A U Desjardins, M.D. “The word ‘laboratory’ is generally defined as a place devoted to experimental study in natural science or to testing, analyzing, or preparing drugs, chemicals, explosives, etc. The advisability of using this word at all in connection with the offices of a radiologist is seriously questioned. There is no better reason that the office and work rooms of a radiologist should be called a laboratory than that the office of any physician should be called a laboratory, because, in both cases, such rooms are not used chiefly for experimental or other allied purposes, but for the examination and treatment of human beings. Consequently, the use of this term does not appear consonant with the true meaning.”

W T Bone, Ph.D. “The term ‘laboratory’ usually connotes a place where experiments are carried on, and therefore it would seem inadvisable to use it in referring to a clinic, for surely clinicians should not advertise that their

treatment has the slightest element of experimentation in it"

A S Warltun, M D "The term 'laboratory' should not be used by radiologists as a designation for an office or establishment in which the use of roentgen rays or radium are employed only in a clinical way, for purposes of diagnosis or therapeutics. Such employment of x-rays or radium no more makes a 'laboratory' than the other methods employed by the physician. In the case of a public institution serving the profession at large for both diagnosis and treatment, the use of the term 'radiological laboratory' seems no more objectionable than 'clinical' or 'pathological laboratory' under similar conditions."

The following is a summation of Dr H J Holmquest. The consensus of opinion of the members of the Council on Physical Therapy is that, since the word "laboratory" usually connotes a place where experiments are conducted for the purpose of scientific research,

such name should not be used to designate the department of a hospital or the private office of a physician where radiological work of a diagnostic or a therapeutic character is carried on.

This correspondence took place in the Spring of 1927. What has happened in the last fifteen years?

Because the physicists, engineers, and chemists continue to perfect our apparatus, making possible a greater inclusion of diagnostic and therapeutic procedures, and because radiologists have conducted themselves with an earnest professional spirit, the terms "laboratory" and "pictures" should be tolerated as descriptive lay terms, condoned as corrupt medical terms, and gracefully accepted as simple expressions, which we *know* connote adjuncts to a service that has emerged from infantilism to reasonable and accepted maturity in two score years. But let us refrain from using them.

M J HUBENY, M D

ANNOUNCEMENTS

MID-SUMMER RADIOLOGICAL CONFERENCE¹

IN THE ROCKY MOUNTAINS,

SPONSORED BY

THE DENVER RADIOLOGICAL CLUB

Wednesday evening, Aug 28, Thursday, Aug 29, and Friday, Aug 30, 1935

Place of Meeting—Shirley-Savoy Hotel, Broadway at 17th St., Denver, Colo. All sessions in the Venetian Garden. (Hotel reservations should be requested in advance of the meeting.)

This Summer the Radiological Club of Denver is attempting a new venture in sponsoring a Radiological Conference for August 28, 29, and 30. The radiologists as well as other members of the medical profession in the Rocky Mountain region have felt the hardship in attempting to attend the various national meetings which are usually held at a considerable distance, and particularly in the East. A majority of the profession find it impossible to attend these meetings and, therefore, lose touch with the progress of medicine. It has been observed that every Summer there are a number of distinguished men who spend their

vacations in Colorado. If given the opportunity these men are usually willing to present some of their recent work. For several years the Colorado Ophthalmological Society and the Colorado Society of Otolaryngology have taken advantage of this situation in conducting a two-weeks course of teaching. These meetings have been very successful and have become well known.

The Denver Radiological Club will not offer any course of teaching but they will make it possible for the radiologists and the medical profession to meet and become acquainted with the work of some of the distinguished men in radiology. Among these guests will be Dr B H Orndoff, Chicago, Secretary of the American College of Radiology, Dr Edward Chamberlain, Philadelphia, Professor of Radiology at Temple University, Dr J M Martin, Dallas, Texas, Professor of Radiology of Baylor University, and Dr Henry S Ullmann, Santa Barbara, California, Director of Cancer Research, Santa Barbara Cottage Hospital.

ORDER OF PROGRAM

Wednesday evening, Aug 28

8 00 P M Joint meeting with the Medical Society of the City and County of Denver

Guest Speakers

W Edward Chamberlain, B S, M D, Professor of Radiology, Temple University Medical School, Philadelphia

¹ A complete program including summary of all papers will be mailed upon request to the Denver Radiological Club, Shirley Savoy Hotel, Denver, Colo. No Registration Fee.

EDITORIAL

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HOWARD P. DOUB, M.D., *Associate Editor*

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W. T. Bowie, Ph.D. "The term 'laboratory' usually connotes a place where experiments are carried on, and therefore it would seem inadvisable to use it in referring to a clinic, for surely clinicians should not advertise that their

Chairman Hamilton I Barnard, M D ,
F A C S , Denver, Secretary of the Rocky
Mountain Orthopedic Club

2 15 P M Development of the Vertebrae and
Intervertebral Discs in Their Relation
to Pathology, Trauma, and Anomalies

F B Stephenson, M D , Denver

2 45 P M Congenital Anomalies of the Spine
John S Bouslog, M D , Denver

3 30 P M The Radiologist's Part in the Prob-
lem of Low-back Pain

W Edward Chamberlain, B S , M D , Pro-
fessor of Radiology, Temple University
Medical School, Philadelphia

4 15 P M Discussion opened by
George K Cotton, M D , Denver

4 30 P M General Discussion

4 45 P M What Conservation can Do in the
Repair of Certain Misplaced Fractures

Samuel B Childs, M D , Denver

5 15 P M Discussion

Scientific Exhibits

The Relation of the Antrum and Cap to the
Gall Bladder

Gastro-intestinal Ulcers and Diverticula
Arthritis

Pulmonary Metastasis

Radiography with the Coolidge Tube in 1915

The Pioneers of Radiology in Colorado

Commercial Exhibits

Eastman Kodak Co , Medical Division,
Rochester, N Y

General Electric X-ray Corporation, Chicago,
Ill

Paul Muckle, Representing The Standard
X-ray Corporation, Denver, Colo

ANNUAL MEETING

DETROIT, DECEMBER, 1935

The Executive Committee has invited Dr
H Holthusen, of Hamburg, Germany, to de-
liver an address Other guest speakers who are
expected are

Dr Chevalier Jackson, of Philadelphia

Dr Charles F Geschickter, of Baltimore

Dr H C Shepardson, Associate Professor of
Medicine, University of California, San Fran-
cisco

Dr J B Collip and Dr Hector Mortimer, of
McGill University, Montreal

COMMUNICATIONS

MINNESOTA RADIOLOGICAL SOCIETY

The Minnesota Radiological Society held
its annual meeting in connection with the
Minnesota State Medical Association at Min-
neapolis, June 24, 1935 Dr Percy Brown
delivered an informal address on "Historical
Reminiscences in the Development of Roent-
genology" and following this gave a demonstra-
tion of the collection of x-ray tubes The
annual Carman Lecture was delivered by Dr
Percy Brown before the State Medical Associa-
tion and his subject was, "The Inception of
Fluoroscopy in the United States and Car-
man's Influence upon It."

New officers for the coming year were elected
as follows *President*, Eugene Leddy, M D ,
Rochester, *Vice-president*, J Richard Aurelius,
M D , St Paul, *Secretary-Treasurer*, Leo G
Rigler, M D , Minneapolis

APPEAL TO THE ROENTGENOLOGISTS AND RADIOLOGISTS OF ALL NATIONS

The fortieth anniversary of the discovery of
the roentgen rays comes in 1935 and we wish to
fulfill a solemn obligation We wish to com-
memorate with gratitude and to venerate all
scientists, physicians, physicists, technicians,
and nurses who were pioneers in roentgenology
and radiology and who lost their lives for the
welfare of mankind in the service of their sci-
ence These men and women from every na-
tion joined their hands in a mighty dance of
death, having paid for the loyalty to their pro-
fession and their love of mankind with excru-
ciating suffering and painful death, while striv-
ing in common for knowledge and in emulation
of the highest human ideals

Lest we, who benefit from their scientific
and medical accomplishments, should forget,
we wish to immortalize them in "Strahlenther-
apie" by publishing a photograph and biogra-
phy of each man and woman who died on the
field of scientific honor in the battle against the
diseases of mankind

Each nation has made some contribution to
this chapter of human heroism We, therefore,
sincerely request that roentgenologists and
radiologists from every country send to the
Editor of "Strahlentherapie" as soon as pos-
sible a photograph and short biographic sketch

H J Ullmann, M D , Director, Department of Cancer Research, Santa Barbara Cottage Hospital, Santa Barbara, Calif

Thursday (morning session), Aug 29

9 00 A M Address "Welcome "

Frederick E Diemer, M D , *President*, The Denver Radiological Club

9 15 A M Symposium on Neoplastic Disease

Chairman Harry Finney, M D , F A C S , Denver

9 30 A M Treatment of Skin and Lip Malig-nancies

H J Ullmann, M D , Director, Department of Cancer Research, Santa Barbara Cot-tage Hospital, Santa Barbara, Calif

10 15 A M Radiation Therapy in the Treat-ment of Carcinoma of the Intra-oral Cavity, Larynx, and Pharynx

J M Martin, M D , F A C R , Professor of Radiology, Baylor University College of Medicine, Dallas, Texas

11 00 A M Treatment of Advanced Malig-nancy

Sanford Withers, M D , Denver, Colo

11 30 A M Discussion opened by

John M Foster, Jr, M D , F A C S , Denver

11 45 A M General Discussion

12 30 P M Special Luncheon

Talks by the Scientific Exhibitors

1 00 P M Round Table Discussion on Prob-lems in Radiation Therapy

Sanford Withers, M D , presiding Present your therapy problems to be answered by our distinguished guests

Thursday (afternoon session), Aug 29

2 00 P M Symposium on Gastro-intestinal Disease

Chairman J N Hall, M D , F A C P , Denver, Professor Emeritus of Medicine, University of Colorado

2 15 P M Further Discussion of the Relation of the Antrum and Cap to the Gall Blad-der as Factors in Emptying the Gall Bladder

Nathan B Newcomer, M D , and Elizabeth Newcomer, M D , Denver

2 45 P M Peptic Ulcer

Ernst A Schmidt, M D , Denver

3 15 P M Discussion opened by

T D Cunningham, B S , M D , F A C P , Denver

3 30 P M General Discussion

4 00 P M Biopsy and X-rays in the Diagno-sis of Intra-uterine Conditions

Benjamin H Orndoff, M D , F A C R , Chicago, Ill , Secretary, American College of Radiology

4 45 P M Discussion opened by

Lyman W Mason, M D , Denver, President of the Denver Gynecological Society

7 00 P M Informal Banquet (\$2 00 per plate)

Frederick E Diemer, M D , presiding "Sunlight and Shadow "

Harmon P Brandenburg, M D , Denver, Hunter and Photographer

Friday (morning session), Aug 30

9 15 A M Symposium on Pulmonary Dis-ease

Chairman Henry Sewall, M D , Ph D , D Sc , Denver, Professor Emeritus of Medicine, University of Colorado

9 30 A M Cystic Disease of the Lungs

L R Moore, Major M C , U S Army, Fitzsimons General Hospital, Denver

10 00 A M X-ray Evidence of Infection in Region of Diaphragm

Leonard G Crosby, M D , and Samuel B Childs, M D , Denver

10 30 A M Inception of Adult Tuberculosis Kenneth D A Allen, M D , Denver

11 00 A M Differential Diagnosis between Pul-monary Tuberculosis and Non-tuberculous Disease of the Lungs

W W Wasson, M D , Denver

11 30 A M Discussion opened by

Cicero L Lincoln, M D , F A C P , Denver, President of the Denver Tuberculosis Society

11 45 A M General Discussion

12 30 P M Special Luncheon

Short talks by the Commercial Exhibitors

1 00 P M Round Table Discussion of Diag-nostic Problems

W W Wasson, M D , presiding Bring your diagnostic problems for discussion by distinguished guests

Friday (afternoon session), Aug 30

2 00 P M Symposium on the Spine Em-bryology, Anatomy, Anomalies, and In-juries

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H W HEFKE M D, of Milwaukee, Wis	I S TROSTLER M D of Chicago, Ill
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(about two typewritten pages) of any of these pioneers in roentgenology or radiology whom they have known intimately

Prof Dr HANS MEYER, Editor of "Strahlentherapie," 73 Parkallee, Bremen, Germany

BOOK REVIEWS

LA ROENTGENTHÉRAPIE DES FIBROMYOMES DE L'UTÉRUS ET DES MÉTROPATHIES HÉMORRAGIQUES By PAUL GIBERT Preface by Dr ANTOINE BÉCLÈRE, member of the Academy of Medicine Published by Masson et Cie, Paris, 1935 Paper, pages 112, illustrations 10 Price, 18 fr

This small book is an attempt to set forth the subject of roentgen therapy for fibromyoma of the uterus and for hemorrhagic metropathies. It is divided into chapters dealing with the clinical or diagnostic phases of the subject, the mode of action of roentgen rays, the relative advantages and disadvantages of roentgen therapy and radium treatment, indications and contra-indications, technic, incidents and accidents that may be observed during treatment, as well as the immediate and late effects of treatment, the influence of irradiation on gestation and heredity, the failures of roentgen therapy, the question of surgery after roentgen therapy, statistics, and conclusions.

This work fulfills its object admirably. The discussion of diagnosis and of the indications and contra-indications is especially good and is based on sound reasoning. In connection with the contra-indications, for instance, Gibert points out that too much has been made of infection as a contra-indication and that in many cases suitable treatment disposes of the infection as well as of the associated fibromyomatous process. As far as the technic of irradiation of fibromyomas is concerned, the methods described are those adopted by the French school under the leadership of the elder Béclère, and involve exposing the part to moderate quantitative doses of roentgen rays at intervals of a week for some time. In the light of present knowledge this seems wholly unnecessary because, as is well known, identical results can be obtained by giving the entire treatment within two or three days. Moreover the in-

cidents or accidents observed during treatment given within a few days are no greater than those described as incidental to the usual French method of treatment. This book is to be recommended to all those who wish up to date and reliable information on the subject, with, perhaps, the technical exception to which reference has been made.

CLINICAL PATHOLOGY OF THE JAWS, with a Histologic and Roentgen Study of Practical Cases By KURT H. THOMA, D.M.D., and CHARLES A. BRACKETT, M.D., Professor of Oral Pathology in Harvard University, Oral Surgeon to the Brooks Hospital, Consulting Oral Surgeon to the New England Baptist Hospital, Consulting Oral Surgeon to the Tumor Clinic of the Beth Israel Hospital. A volume of 643 pages, 171 case histories, 423 figures, and 8 color plates. Published by Charles C. Thomas, Springfield, Ill., 1934. Price, \$9.00.

This volume is an extremely valuable contribution to pathology and roentgenology of the jaws. Much of the material is presented by means of reports of cases encountered by the authors and by others, with excellent illustrations of roentgenograms and microscopic sections of tissue. Both the roentgenograms and the photomicrographs are extremely well reproduced. Although the book contains reports of many cases of the sort usually seen in this type of text, many unusual cases are also presented, such as cases of actinomycosis of the jaw. The colored photomicrographs of this condition are the best that this reviewer ever has seen. The classification of tumors of the jaw is based on clinical as well as microscopic examination of the tissue. Inflammatory lesions as well as neoplasms have been studied roentgenologically and microscopically, making a very interesting collection of material. The bibliography is voluminous, which makes the book of great value to the student.

Although the book should be of interest to the dentist who wishes collateral reading, it should also serve as a reference book for the roentgenologist and pathologist who is doing general work and who, at times, has to make diagnoses in a specialized field such as this. All in all, it is an extremely well prepared and illustrated volume, which deserves much commendation.

ARTERIOGRAPHY

Technical Considerations in Arteriography of the Extremities with Thorotrast J Ross Veal and Elizabeth M McFetridge *Am Jour Roentgenol and Rad Ther* July, 1934, 32, 64-71

A method has been devised which can be carried out by one person and eliminates both incision and the tourniquet. The skin is anesthetized with 1 per cent procain, and the artery is punctured with a No 18 needle attached to a syringe filled with the solution. As soon as the puncture is accomplished, pressure is made with the thumb over the artery just proximal to the site of injection and is continued until all the solution has been introduced. It is then released and the exposure is made from three to six seconds later depending on the distance between the site of injection and the location of the pathology. Thorotrast gave the authors the best results 12 cc being sufficient for leg and foot, and 20 to include the lower thigh, 5 to 10 for the arm. If the subclavian is injected, a roentgenogram is made at the conclusion of the injection.

This work has been done on 150 cases including gangrene, embolic or thrombotic obstruction, angiospasm, arterio-venous aneurysm, and fibroblastoma of the sciatic nerve.

S M ATKINS, M D

Arteriography A Roentgenographic Study of the Peripheral Arteries of the Living Subject Following Their Injection with a Radiopaque Substance. Edgar V Allen and John D Camp *Jour Am Med Assn* Feb 23, 1935, 104, 618-623

In the extremities the arterial circulation as a whole may be adequate even when some of its component parts are badly diseased. There are many methods for determining the sufficiency of the entire arterial circulation to extremities that leave little to be desired in determination of the efficiency of the arterial circulation as a whole. This situation is sharply in contrast to study of any component parts of the peripheral circulation. Arteries except large ones are not ordinarily visualized roentgenographically unless there is calcification in the walls, and even then no information can be gained regarding their caliber.

Arteriography was first carried out on living subjects in 1923. The ideal arteriographic substance is one which can be injected into an artery without producing pain or immediate or delayed toxic effects and which is of good radiopacity in spite of the unavoidable dilution by the blood after injection. The authors used thorium dioxide sol (18 to 20 per cent by weight of thorium dioxide). In the interpretation of roentgenograms of the peripheral arteries, congenital variations from the usual formation of the vascular system, alterations in the lumen of arteries as irregularities in contour, diminution of caliber, complete occlusion, and the presence or absence of collateral circulation and its situation and extent. Normal variations in formation

of the arterial system are many. The normal arteriogram is characterized by (1) smooth and uninterrupted contour of the lumens of the injected arteries, (2) direct course of these vessels, and (3) presence of no more than a minimum of collateral circulation. The size of the lumen varies in different subjects, and a small artery alone is not, primarily, evidence of disease.

The roentgenographic appearance of diseased arteries in thromboangitis obliterans, the development of collateral arteries in an attempt to compensate for occlusion of the main trunks, arteriosclerosis and aneurysm or arteriovenous fistula are discussed in detail. The chief value lies not in the direction of diagnosis but in that of pathogenesis. It gives information of inestimable value regarding the minutiae of arterial disease, information which can be secured in no other way. The situation, extent, and nature of aneurysms, arteriovenous fistulae and arterial emboli can be determined accurately by arteriography. Whether or not the method will add information of value to knowledge of the pathogenesis of arthritis, hypertension and other conditions remains with the future to determine.

CHARLES G SUTHERLAND M D

ARTHRITIS

What should a Patient with Arthritis Eat? Walter Bauer *Jour Am Med Assn*, Jan 5 1935, 104, 1-6

In this discussion the author states that no dietary can be adequately presented without stressing the fact that an accurate diagnosis is the first requisite. Some simple, workable classification should be followed by all. He divides his classification into those groups in which the origin is known and those in which the origin is unknown or uncertain. The first is subdivided into (1) the traumatic, which includes synovitis, loose bodies and cartilages and sprains. In a second group he places those in which a bacterial agent is the known causative factor, tubercle bacillus, gonococcus, staphylococcus, streptococcus, pneumococcus, meningococcus, typhoid bacillus, dysentery organisms (amebic and bacillary), those due to the spirochete of syphilis, acquired and congenital (tenosynovitis syphilitica), influenza bacillus and Brucella organisms. A third group includes the neuro-arthropathies (Charcot's joints), tabes dorsalis, syringomyelia, leprosy, etc., the fourth, those considered as metabolic in origin, such as gout, the fifth constitutional as hemophilia and hysteria and the sixth, the anaphylactic associated with serum sickness. With such a classification, one should be able to differentiate and properly diagnose the various arthritides. The arthritides of unknown origin which embrace the degenerative (hypertrophic, osteo arthritic, Type II arthritis), the proliferative (rheumatoid, atrophic, Type I, or chronic infectious arthritis) and rheumatic fever represent the types that have given rise to so much controversy concerning the diet in arthritis.

Degenerative arthritis is the result of 'wear and tear' of increasing age and repeated trauma, the name adequately describes the cartilage changes that are

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CANCER (THERAPY)

Roentgen Therapy of Epitheliomas of the Pharynx and Larynx Maurice Lenz, Cornelius G Coakley, and Arthur Purdy Stout *Am Jour Roentgenol and Rad Ther*, October, 1934, 32, 500-507

During 1931 and 1932, 31 epitheliomas of the larynx and pharynx were treated in the radiotherapy department of the Presbyterian Hospital, in New York City, initial exposure of the first case being given on Dec 27, 1930, and the final treatment of the last case on Jan 19, 1933. Only microscopically verified epitheliomas are included in this series.

It is considered important to improve to the maximum the oral hygiene of each case before beginning treatment. Extraction of carious teeth from a vigorously irradiated jaw frequently results in a late radio-necrosis of bone.

Using a constant potential machine, the following factors were adopted: 200 K V, 8 ma, 50 cm target distance, 1.88 mm copper and 1 mm aluminum filter, size of field usually 6×8 , 8×10 , or 10×10 cm. average daily dose was 400 r without back-scattering to one field, administering 10 r per minute. The total dosage applied over two opposing fields varied from 2 800 to 4 800 r in successful cases, and from 2 400 to 5 000 r in the failures. The total dosage administered per patient varied from 5,600 to 9,400 r in the arrested, and from 7,500 to 13 000 in the non arrested cases. (The larger dosage in the last mentioned group was due to longer duration of treatment and a larger number of fields of irradiation.) In most cases any given field was exposed on alternate days, save Sundays and holidays, except in cases in which three portals of entry were used, when a given field was exposed every third day. Treatments were continued until a definite confluent pseudo diphtheritic membrane covered the irradiated part of the mucosa ("radio-epithelitis"). This reaction disappeared two or three weeks later, leaving a slightly dry mucosa as the only residue. The membrane started to appear two or three weeks after the first treatment, but irradiation was continued until this membrane became pronounced and confluent. In the average successfully treated cases radiation was continued over an interval of 30 days and in the unsuccessful case an average of 32.7 days. The radio-epithelitis of the irradiated skin occurred and healed during about the same interval as the mucosal reaction. The patients were ambulatory up to the time of the appearance of the mucous membrane reaction, then were hospitalized until it had subsided. Fluids are forced despite severe dysphagia, it being only occasionally necessary to resort to procto- or hypodermoclysis.

Thirty-one patients received this treatment, only 24 cases offered irreproachable clinical data for evaluation of the method. Of these, 11 of the 24 have shown no clinical evidence of recurrence for from nine months to two years since the last treatment while in 13 cases this therapy failed to arrest the disease.

Microscopic classification of the tumor was as follows in the radiosensitive group: infrequency or absence of keratinization; few or no intercellular bridges, marked variation in the size and staining quality of cells and nuclei, numerous mitotic figures, and minimal inflammatory reaction. Radioresistant tumors showed the opposite microscopic picture. The doubtful group showed a mixture of radiosensitive and radioresistant characteristics.

Of the 13 failures, 10 were classed radioresistant microscopically, and of the 11 clinically arrested, nine were found to be radiosensitive and two mixed.

There were unilateral clinical metastases in the regional glands in six of the 11 apparently arrested cases, and in nine of the 13 failures. Tumors which are deeply infiltrated or badly infected do not respond well.

A few of these cases had tracheotomy performed before starting roentgen therapy. The tracheotomy tube was removed before and reinserted after each treatment.

Sticky, tenacious mucus is regularly encountered during Coutard therapy over the cervical areas, and dryness due to lack of saliva persists for months after treatment. The taste sensation is often lost and weight is regularly lost. However the taste sensation usually returns gradually and the weight is regained in the responding cases.

J E HABBE, M D

COLITIS, ULCERATIVE

Ulcerative Colitis II The Factor of Deficiency States Thomas T Mackie *Jour Am Med Assn*, Jan 19, 1935, 104, 175-178

Deficiency disease was encountered in 47 cases of chronic ulcerative colitis out of 75 consecutive cases (62.6 per cent) seen in hospital, dispensary, and private practice in New York City.

The objective changes find expression particularly in the mucous membranes of the mouth, in the skin, in changes in the blood chemistry, and in the associated anemia. Alterations in the mucous membrane of the tongue have been the most common of the abnormal manifestations. They appear to be among the earliest recognizable indications of deficiency disease. They present the features that are characteristic of sprue, pernicious anemia and pellagra. Alteration in the texture of the skin has been the most common change observed.

Both the protein and the mineral metabolism of the body may be seriously disturbed in the advanced stages of chronic ulcerative colitis. Thirty-nine of the 75 cases showed significant grades of anemia. Twenty-nine of 37 cases studied roentgenographically showed significant changes in the small intestine. These frequently extended from the duodenum to the ileocecal junction. The normal mucosal pattern was distorted, as though the mucosa, and especially the valvulae conniventes were edematous. There was dilatation of individual coils and groups of coils without evidence of obstruction. There was disorganization

always observed in this type of joint disease. Simple weight reduction will often result in weight-bearing joints becoming symptom free. Some of the marginal joint changes may be responsible for the symptoms, once these have become quiescent the symptoms will disappear.

One of the most important things to be remembered concerning rheumatoid arthritis is that the disease is characterized by remissions and relapses. Remissions may last months or years. The diet for this group is discussed in detail. Treat the patient as a whole and observe the effect on the course of the disease. There is no specific diet for patients with arthritis of known origin, with the exception of gout.

C G SUTHERLAND, M D

BONE DISEASES (DIAGNOSIS)

Osteitis Fibrosa Cystica and Renal Calculi without Hypercalcemia. Clarence L. Robbins. *Jour Am Med Assn* Jan 12, 1935, 104, 117, 118.

The so-called metabolic criteria of hyperparathyroidism may be duplicated in conditions in which there is no evidence of hyperfunction of the parathyroids. Likewise in proved cases of hyperparathyroidism the metabolic criteria may be absent.

The author reports a case of osteitis fibrosa cystica generalisata as an instance of probable hyperparathyroidism fulfilling all the clinical and roentgenographic criteria of the condition with consistently normal concentrations of calcium and phosphorus in the serum. The patient was first admitted in 1922 when she was 48 years of age, for nephrectomy on the right side because of renal calculi and pyelonephritis. She was readmitted in 1933 when roentgen examination revealed a fracture through the middle third of the femur, with decalcification and multiple cysts in the distal fragment producing marked distortion of trabeculations and expansion of the cortex. Similar cysts and osteoporosis were present in the right radius. The skull was the site of spotty rarefaction and thickening, rather suggesting Paget's disease. The twelfth thoracic and third lumbar vertebral bodies were markedly narrowed in their vertical diameters as the result of compression. In view of the osteoporosis multiple cystic tumors and renal calcification hyperparathyroidism was diagnosed, the patient refused surgical intervention and died shortly afterward. Necropsy was not obtainable.

C G SUTHERLAND M D

CANCER (DIAGNOSIS)

Carcinoma of the Rectum. Some Causes for the Poor Prognosis. J. Arnold Bagen and Eugene T. Leddy. *Jour Am Med Assn* April 6 1935 104, 1201-1203.

Many patients who have carcinoma of the rectum appear at the Mayo Clinic and elsewhere for examination when the local lesion is hopelessly inoperable.

This also implies that many of these lesions are beyond even palliative irradiation when first seen. When it is recalled that carcinoma of the rectum causes definite and annoying symptoms such as rectal bleeding, pain, constipation and diarrhea which get progressively worse, and that about 95 per cent of all these lesions are within reach of the examining finger these facts are disheartening.

A careful analysis of the answers obtained from 200 patients led them to conclude that the poor prognosis of carcinoma of the rectum is the result of the following causes: (1) The frequent wasting of valuable time on the part of patients by self-diagnosis and self-treatment and by regarding the symptoms as unimportant, (2) delay by the physician in making a digital examination of the rectum, (3) lack of knowledge on the part of the patient, concerning the safety and satisfactory end results of rectal surgery.

C G SUTHERLAND, M D

Cancer of the Transverse Colon in a Seven-year-old Boy. Damon B. Pfeiffer and J. K. W. Wood. *Jour Am Med Assn* April 6 1935 104, 1227-1229.

Cases of carcinoma of the intestinal tract occurring in young persons must be looked on as extremely uncommon. Wainwright found only seven cases of cancer of the colon above the sigmoid in children. These authors tabulate eleven cases all reported in children under 15 years of age.

They report a case of a boy aged seven in whom the barium enema was abruptly arrested about two inches above the level of the iliac crest in the descending colon. Surgical intervention because of the obstruction was followed by alkalosis, failing heart and death. The pathologic examination revealed a fibroma showing superficial ulcerations, hemorrhages, extensive round cell infiltration and several fields of misplaced irregularly enlarged and distended intestinal glands which strongly suggested the presence of adenocarcinoma. Histological examination revealed a fibroma with adenocarcinomatous changes.

CHARLES G. SUTHERLAND M D

The Diagnosis of Early Cancerous Changes in Peptic Ulcer. Arthur L. Bloomfield. *Jour Am Med Assn*, April 6 1935 104, 1197-1201.

The author discusses the various diagnostic methods and criteria that have long been considered valuable in the diagnosis of carcinoma of the stomach and concludes that none are reliable in the individual case. The only practical attitude to adopt therefore is to regard small apparently innocent gastric ulcers as in fact benign until evidence to the contrary is weighty enough to arouse serious suspicions and to accept the fact that a certain number of unavoidable tragedies will occur. They will occur in the future as they have in the past not necessarily because physicians are careless but because they are helpless in the face of an insoluble problem of diagnosis.

C G SUTHERLAND M D

nerve supply to the affected areas of the body Since 1923, deep roentgen therapy has been used, the amount applied being from 75 to 100 per cent erythema dose per area All patients were ambulatory In most cases following treatment, the itching increased, to be soon followed by complete cessation of the symptom Three weeks after treatment the color faded, the scales became loosed, and the surrounding skin infiltration was diminished

In most cases a second series of treatments were given after from six to eight weeks Complete disappearance of the lesions occurred in from three to six months after the last treatment, in some a year The cases treated were of many years' standing

S M ATKINS M D

ESOPHAGUS (DIAGNOSIS)

Peptic Esophagitis A New Clinical Entity Asher Winkelstein Jour Am Med Assn, March 16, 1935, 104, 906-909

The causes of esophagitis are usually given as irritative (mechanical, thermal, and chemical irritants including alcohol and tobacco), specific (syphilis, tuberculosis, and actinomycosis), secondary as a complication of (a) cardiospasm, (b) diverticula, or (c) neoplasms

Recently the author has observed some patients with a type of esophagitis that does not seem to fit into this classification The patients were all elderly men in whom, because of certain esophageal symptoms carcinoma was suspected The prolonged course of the disease and the results of biopsy were sufficient to exclude that diagnosis Observations suggested the disease resulted from the irritant action on the mucosa of free hydrochloric acid and pepsin The eroding gastric juice, rising into the lower part of the esophagus and held there by a mild spasm of the cardia may injure the mucosa, made susceptible by age and the "ulcer constitution" Secondary infection may readily explain the more or less purulent nature of the inflammation Association with duodenal, gastric, and pre existing peptic ulcer of the esophagus was noted in some of his cases

CHARLES G SUTHERLAND, M D

FEVER THERAPY

Fever Therapy for Gonococcal Infections Arthur U Desjardins, Louis G Stuhler, and Walter C Popp Jour Am Med Assn, March 16, 1935 104, 873-878

In the past, many observers have noted an inhibitory effect of high temperature on gonococcal infections Bacteriologists have long known that *Neisseria gonorrhoea* can best be isolated and cultivated at a temperature of 37° C (98.6° F), and that the organism does not grow so well at temperatures greater than 38° C (100.4° F)

For a number of years artificial fever induced by the injection of bacteria or protein substances, by general diathermy or by short wave radiations, the heating effect of which was fortuitously discovered by Whitney

who also realized its possible therapeutic value, has been used to treat syphilis of the nervous system, chronic arthritis and certain other conditions During the last few years also the value of this method in treating acute gonococcal arthritis has been made increasingly clear The rapid relief from pain and subsidence of inflammation obtained by thorough heating of the affected joints themselves, without general elevation of body temperature, is remarkable enough, but still more startling is the almost theatrical effect of increasing the general body temperature of such patients to between 41.1° C (106° F) and 41.7° C (107° F) and maintaining it at this level for five or more hours

The average number of sessions of fever required to effect a cure was 5.4 The largest number of sessions required was twelve, in one case, this was owing to the fact that, during early sessions, an adequate degree of fever was not attained or was not maintained long enough The lowest number of sessions of fever required for cure in any case was three Later, an interval of only two days was allowed to intervene between sessions

Fever therapy, especially for conditions requiring a high temperature, should be conducted in an institution where adequate facilities and trained personnel are available It cannot be carried out in conjunction with other medical practice without increased risk,

CHARLES G SUTHERLAND, M D

Fever Therapy Results from Gonorrheal Arthritis, Chronic Infectious (Atrophic) Arthritis, and Other Forms of "Rheumatism" Philip S Hench, Charles H Slocumb and Walter C Popp Jour Am Med Assn May 18 1935, 104, 1779-1790

It has been observed clinically and experimentally that the lowering of body temperature diminishes the resistance of a host, human and otherwise, to certain bacterial infections There is experimental evidence to support the contention that high temperatures exert a bactericidal and bacteriostatic effect on certain germs *in vitro* These observations provided the impetus for a trial of hyperpyrexia in the treatment of various diseases, including arthritis Regardless of the method used, whether diathermy, radiotherapy, hot baths, or heated cabinets, the resultant hyperthermia is characterized by more or less identical physiologic effects These are reviewed in detail Many of the reactions are of little or no importance from the standpoint of resultant discomfort or of relief The benefits of fever therapy presumably arise from (1) a direct bacteriolytic or bacteriostatic effect due to the influence of heat itself on bacteria (without necessarily implying formation of immune bodies), (2) an indirect bacteriolytic or bacteriostatic effect resulting from increasing formation or mobilization of immune bodies (3) a local effect from vasodilation, providing an augmented blood supply to the inflamed tissues, and (4) a general effect from the heightened metabolism incident to fever An arthritic patient may be helped by any one of these factors acting alone or in combination

of normal motor function, with reduction of activity and uncoordinated muscular contraction. No evidence of ulceration of the small intestine was obtained. These changes were constantly present and most marked in patients with advanced grades of deficiency disease. Although the experimental evidence is striking, clinical experience has not supported the view that avitaminosis may operate as a primary cause of ulcerative colitis.

Studies have led to the belief that deficiency states play an important part in the mechanism of chronic ulcerative colitis. The lack of clinical signs of deprivation in a proportion of cases suggested that the factor of deficiency was secondary rather than primary. Deficiency disease is not to be regarded as an occasional complication of chronic ulcerative colitis. It seems more probable that it constitutes an essential part of the underlying mechanism.

C G SUTHERLAND, M D

THE CRANIUM

Observations on Encephalography. Campbell Howard. *Am Jour Roentgenol and Rad Ther*, Septem-ber, 1934, 32, 301-310.

Luminal is used in 4.5 grain amounts every hour for two or three doses before the injection. This prevents the vomiting, although the headaches are not definitely affected. Views are taken in the erect and prone positions without the Bucky at 6 ft distance. The vertical views are best for subarachnoid visualization and horizontal for the ventricles.

Combined enlargement of both ventricles and subarachnoid space is pathognomonic of cerebral atrophy or destruction.

The definite localization of frontal lobe tumors is of great aid to the surgeon. Subdural air is definitely associated with decreased intracranial pressure and is found in epilepsy and atrophy from vascular lesions. It may be due to an arachnoidal defect around enlarged Pacchionian granulations. Observation of bone atrophy is very important in diagnosis of epilepsy or expanding intracranial lesions.

S M ATKINS M D

Cerebral Neoplasms. The Diagnosis in the Absence of Generalized Intracranial Pressure Phenomena. A E Bennett and J J Keegan. *Jour Am Med Assn*, Jan 5 1935, 104, 10-16.

The authors deal with the diagnosis in the absence of generalized intracranial pressure phenomena, this classic cardinal symptom being lacking in from 15 to 30 per cent of large groups of patients with intracranial tumors, according to the studies of many observers. The principal cause of cranial hypertension is disturbance of the outflow of the cerebrospinal fluid. A tumor seems to raise intracranial tension very little until its growth interferes with the circulation of the cerebrospinal fluid. The location of the tumor is highly important in the production of early or late pressure

phenomena. Midbrain and subtentorial tumors practically always show early pressure signs while frontal lesions may develop to an unusual size without increased intracranial pressure.

The manometer in the authors' hands gives the most reliable and earliest guidance in the diagnosis of a pressure lesion. Such roentgenographic signs as evidence of local calcification, rarefaction of bone in creased diploic vessel marking, and shifting of the pineal shadow are valuable aids in diagnosis and localization. These occasionally give leads to diagnosis of tumor before neurologic signs are present.

It has been the practice of the authors to recommend encephalography in all adult epilepsies. The more frequently they resort to this examination the higher they find the percentage of organic causes for convulsions. With the aid of encephalography and experience, perhaps some of the malignant gliomas can safely be declared inoperable.

C G SUTHERLAND, M D

DERMATOLOGY

Röntgen Therapy in Dermatology. Joseph Jordan Eller. *Am Jour Roentgenol and Rad Ther*, August, 1934, 32, 218-221.

X rays are used in dermatologic practice in the following instances: (1) when it is desirable to epilate hair temporarily (tinea capitis, favus, sycoosis, and nevus pilosis), (2) to reduce sebaceous gland activity (acne vulgaris and rosacea and seborrhea), (3) to reduce sweat gland activity (hyperhidrosis, bromidrosis, chromidrosis, pompholyx and hydrocystoma), (4) to alter metabolism of the regional cells in order to render less favorable the growth of bacteria and fungi (in skin tuberculosis, fungus infections, furunculosis, etc.), (5) for the relief of itching, and (6) for caustic or destructive effect (skin malignancies).

The "skin unit" of unfiltered rays that quantity just sufficient to cause temporary epilation is given at 350 r. While there are, of course, individual variations in susceptibility, one may ordinarily administer 85 r weekly for three months to the face without immediate or ultimate reaction. Care is necessary in the treatment of inflammatory lesions because of the increased effect of the rays. Acute and chronic simple inflammatory dermatoses involving predominantly the epidermis may be given 42 to 85 r once weekly while lesions involving the cutis with considerable infiltration and larger granulomas require more intensive treatment and the use of filters of from 1 to 3 mm of aluminum.

J E HABBE M D

Irradiation in the Treatment of Psoriasis. Rieva Rosh. *Am Jour Roentgenol and Rad Ther*, July 1934, 32, 82-86.

After discussing the various causes and methods of therapy that have been attempted, the method of treatment at Bellevue Hospital, New York City, is described. Since 1924 roentgen rays have been applied to the spine at those levels which correspond with the

nerve supply to the affected areas of the body. Since 1928, deep roentgen therapy has been used, the amount applied being from 75 to 100 per cent erythema dose per area. All patients were ambulatory. In most cases following treatment, the itching increased, to be soon followed by complete cessation of the symptom. Three weeks after treatment the color faded, the scales became loosed, and the surrounding skin infiltration was diminished.

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CHARLES G SUTHERLAND, M D

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CHARLES G SUTHERLAND, M D

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The following conditions have been considered to be contra indications to fever therapy advanced age myocardial and renal insufficiency marked hypotension, active tuberculosis, aortic aneurysm, rapidly progressing late neurosyphilis, and abnormal conditions of the skin which interfere with adequate sweating

The results in gonorrheal arthritis are in striking contrast with those in non specific infectious arthritis, the figures in the two groups being almost the converse of each other Of 60 patients with chronic infectious arthritis a total of 30 per cent received significant benefit and 70 per cent, little or no relief About 90 per cent of patients with gonorrheal arthritis were essentially cured or markedly relieved

CHARLES G SUTHERLAND, M D

FISTULA

Duodenorenal Fistula George C Biondi Jour Am Med Assn, May 25, 1935 104, 1894-1897

The author found but three cases of fistulous communication between the duodenum and the pelvis of the right kidney recorded in the entire medical literature The first two were found at autopsy, a third recent case was demonstrated by urography In the case reported the fistula was demonstrated by urography and on surgical intervention the finding was corroborated A subsequent nephrectomy was done and the pathologic report on the tissue was tuberculosis of the kidney

The author believes the ulcerative process originated in the duodenum because the gastro intestinal complaint preceded the urinary disturbance by several months, because of the repeated failure to encounter any obstruction of the right renal tract, and because of lack of evidence of tuberculous changes on pyelography

CHARLES G SUTHERLAND, M D

GALL BLADDER (NORMAL AND PATHOLOGIC)

Relation of Cystic Duct Obstruction to Deposition of Calcium in the Human Gall Bladder Elliott C Cutler and Robert Boggs Jour Am Med Assn, April 6 1935 104, 1226 1227

The importance of cystic duct obstruction on the deposition of calcium has been fairly well established both clinically and experimentally The authors report a case which they feel further substantiates the theory that obstruction of the cystic duct initiates the deposition of calcium and seems to represent an early stage in that process The gross specimen obtained by cholecystectomy showed a mucosa of light pinkish-gray and no area of erosion could be seen The lumen contained 50 c c of an extraordinarily tenacious greenish gray mucoid substance Embedded in this material were nine large spherical white stones These had a linear distribution extending from the fundus into the neck The cystic duct was completely obstructed by a reddish yellow stone of similar size

Throughout the fundal portion were scattered many small whitish stones roughly estimated at 200 The larger stones average 7 mm in diameter and the smaller ones 2 millimeters The cut surface of the stones was reddish brown with radiating crystalline markings The periphery of all the ones with the exception of a few of the smaller ones and the one in the cystic duct, was formed by a very thin layer of chalky white material Examination of the bile showed calcium 28 mg per 100 c c, cholesterol 750 mg and bile salts 0 The absence of bile pigments is compatible with the views of Andrews and his co-workers that absence of bile salts is an important factor in cholesterol precipitation

CHARLES G SUTHERLAND M D

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Changes in the Gastro-intestinal Tract in Deficiency States with Special Reference to the Small Intestine A Roentgenologic and Clinical Study of 40 Cases Thomas T Mackie and Robert E Pound Jour Am Med Assn, Feb 23 1935, 104, 613-618

Deficiency disease may result from a defective dietary or from abnormal physiology of the gastro-intestinal tract Defective absorption constitutes one of the outstanding features of sprue, and in certain cases has been shown to condition the development of the deficiency factors of the disease The observation of advanced deficiency disease in several severe cases of ulcerative colitis led to a detailed clinical and roentgenologic investigation of a large group of cases of chronic ulcerative colitis Evidence of deficiency states was found in 63 per cent of 75 cases studied Consideration of possible etiologic factors suggested among others too rapid passage of the food constituents through the intestinal tract or abnormalities of the small intestine producing defective absorption of the products of digestion

Three cases of sprue and 37 cases of chronic ulcerative colitis were studied roentgenographically Changes encountered in the small intestine were variation in the contour and size of the lumen and alteration of the normal motor phenomena The duodenum showed a thickening or widening of the circular markings in almost all severe cases and in certain of the moderately severe ones The lumen was frequently dilated and contained gas The appearance resembled duodenitis except that no contracture or spasm was noted

In the jejunum the valvula conniventes were thickened and the spacings between them were widened The normal mucosal pattern was distorted by the irregularities in the size of the valvula conniventes, in the partially filled segments it was often bizarre in appearance The lumen was frequently dilated and this dilatation was confined to local groups of coils or to isolated coils

The changes in the ileum were quite similar to those noted in the jejunum The outstanding feature of the rate of progress of the barium meal through the small

intestine is that the rapidity was not increased over the normal. The shortest emptying time was four hours. Twenty-four of the cases of chronic ulcerative colitis and the three cases of sprue showed a definite 24 hour barium residue in the colon. The barium enema in cases presenting the small intestinal changes has shown no constant relationship between these abnormalities and the extent and the severity of the lesions in the colon. In numerous instances, changes in the small intestine have been associated with a normal cecum and proximal colon.

The actual pathologic condition underlying the roentgenologic changes is not definite. The nature of the processes leading to these phenomena is obscure. The changes are those which could be produced by edema of the mucous membrane, disorganization of the normal motor activity, and reduction in tone of the intestinal musculature.

C G SUTHERLAND, M D

Enterogenous Cysts of the Duodenum. Report of a Case and Review of the Literature. Clarence E. Gardner, Jr., and Deryl Hart. *Jour Am Med Assn*, May 18 1935, 104, 1809-1812.

Cysts and diverticula of the gastro intestinal tract represent congenital abnormalities that are a problem to the clinician in diagnosis and to the surgeon in treatment.

Cysts of the duodenum have been noted in the literature only six times—two were in new born children, one in a 3 weeks-old infant, one in an infant aged 19 days, one in a 3 months-old child, and the other in a 2-weeks-old female infant. In the case the authors report the patient was a girl 15 years of age.

Cysts which reduplicate all the layers of the normal intestine have their origin in defects of development of the intestinal tract. A cyst thus formed may occupy any position within the intestinal wall—submucous, intermuscular, or subserous—or any position around the intestinal wall—mesenteric, antimesenteric, or any intervening segment. A cyst on the mesenteric border, in addition, may lose its attachment to the intestine and occupy any position between the two layers of the mesentery. In none of the cases reported was the diagnosis made before operation. The most important diagnostic points are the presence of a tumor in the region of the duodenum and the signs and symptoms of duodenal obstruction. In those cases in which excision is not possible, the procedure of choice is permanent internal drainage of the cyst into the intestinal tract. An embryonic diverticulum is the probable origin of the cyst.

CHARLES G SUTHERLAND, M D

Pain in Benign Ulcers of the Esophagus, Stomach, and Small Intestine. Andrew B. Rivers. *Jour Am Med Assn*, Jan 19 1935, 104, 169-173.

The clean-cut syndrome usually accepted as being diagnostic of peptic ulcer indicates an uncomplicated ulcer. When the pain of gastric ulcer shifts definitely

to the left, slightly upward, or to the back, and when the pain of a duodenal ulcer is projected toward the right, upward through the region of the liver, or through to the back, or when the pain of a gastrojejunal ulcer extends downward, or through to the back, one can usually correctly assume deep penetration or partial perforation of such a lesion. The presence of two distinct separated areas of pain, especially if such pain is projected into two widely separated areas, frequently is indicative of two peptic lesions, such as an associated duodenal ulcer and gastrojejunal ulcer, or an associated gastric ulcer high on the lesser curvature, and a perforating duodenal ulcer. The situation of the pain of an obstructing ulcer, regardless of the situation of the lesion, is usually diffusely spread out over the epigastrium. Uncomplicated peptic ulcer probably indicates its presence as a visceral phenomenon which asserts itself over the splanchnic nerves. The projecting pain of perforating peptic ulcers is probably the result of direct stimulation of the somatic nerves, with a relay of these impulses as pain into the peripheral or cutaneous branches of such nerves.

It is conceivable that the distortion of the approved ulcer syndrome in such instances is influenced by the accumulation of impulses of varying intensity over both the splanchnic plexuses of nerves and over the somatic nerves.

C G SUTHERLAND, M D

Radiographic Studies of the Vascularization of the Blood Supply of the Ileo-ceco-colic Region in Man. Eugenio Rebustello. *Arch di Radiol*, 1934, 10, 532.

The author here summarizes some observations he made on the blood supply of the ileo-ceco-colic region in 50 subjects, varying from full term babies to adults of both sexes, and illustrates radiographically the usual distribution of the vessels and some of their anomalies.

E T LEDDY, M D

GENITO-URINARY TRACT (DIAGNOSIS)

Comparison of the Urinary Tract in Pregnancy and Pelvic Tumors. Edgar C. Baker and John S. Lewis, Jr. *Jour Am Med Assn*, March 9, 1935, 104, 812-815.

The study by intravenous dyes of the urinary tract in pregnancy meets ideal conditions. It is known that intravenous urography succeeds best when a certain degree of obstruction between the kidney and the bladder co-exists with a fair to good excretory function of the kidneys. Studies have revealed a high degree of dilatation of the upper urinary tract. This dilatation is more marked on the right side. It was early apparent that the position of the fetus had no effect on the dilatation. No real dilatation occurred until the uterus rose into the abdomen, it was more pronounced after the fourth month until close to term, when it appeared to subside slightly in some cases. At the third month, however, the upper tract on the right side showed better filling with the excreted dye than is usually seen in normal, non pregnant patients. The stasis thus

demonstrated helps to explain the frequency of pyelitis or urinary infection in pregnancy.

Roentgenograms taken in the oblique positions showed clearly the relation of the sigmoid to the lower left ureter. The authors feel that the torsion of the uterus to the right is due to the sigmoid, and it seems a logical explanation of the cause of the rather marked right sided preponderance of urinary dilatation. The sigmoid protects the left ureter and probably is the cause of the torsion of the uterus, with resultant increased pressure on the right ureter. Comparative studies of fibromas and ovarian cysts supported the mechanical obstructive theory.

CHARLES G SUTHERLAND, M D

GENITO URINARY TRACT (THERAPY)

Bilateral Urinary Calculi with Special Reference to Therapeutic Problems. Alexander R Stevens. Jour Am Med Assn April 13 1935, 104, 1289-1295.

The therapeutic problems peculiar to bilateral urinary calculi are not solved by the application of stated formulas. In clinical work one must secure data as complete as possible concerning the patient in general and his urinary tract in particular. The size and location of all calculi should be known, whether or not they obstruct as well as the total renal function, the relative function of the two kidneys, and the presence or absence and degree of infection of both kidneys. There is no dependable method of dissolving calculi, but stones may pass spontaneously through the renal channels or be removed by operation.

Large, non infected non-obstructing symptomless stag horn calculi are usually left alone. Also, there is questionable advantage in trying to remove a large mass of non-obstructing, symptomless small stones occupying an entire kidney. There is no hurry in operating for small symptomless stones in a kidney even in the presence of low grade infection whereas one does not dare wait long for the spontaneous passage of ureteral calculi associated with urinary infection. Relief of obstruction by a ureteral catheter if possible, is usually a relatively harmless procedure, it may give temporary relief from symptoms and danger may be followed by spontaneous passage of a calculus. Ureterotomy is one of the least dangerous major operations. Pyelotomy entails an added risk and nephrotomy particularly if extensive is decidedly more dangerous. As a rule ureterotomy and pyelotomy cause no immediate or remote decline of renal function whereas in some cases nephrotomy has been followed by a decided though perhaps transient retention of non protein nitrogen in the blood within a week or ten days. Secondary hemorrhages and acute kidney infections when they do occur after operation are usually encountered after nephrotomy incisions and not after pyelotomy. The more nearly complete urinary obstruction is, the more rapidly will kidney injury occur. The greater this injury the less the return to function is to be anticipated following operation.

The data of 35 operative cases are reviewed, largely to

illustrate the fallibility of commonly accepted ⁷rules. One should seek improvement of renal function primarily, and eventually control of infection and alleviation of symptoms.

CHARLES G SUTHERLAND, M D

GYNECOLOGY AND OBSTETRICS

Sterility and the X rays. Max Huhner. Jour Am. Med Assn, May 18 1935, 104, 1808-1809.

X rays in sufficient doses interfere with the spermatogenic function of the testicle or destroy it entirely. It must be recognized that different testicles react differently to the influence of the x rays, some being more sensitive than others, so that what might be adequate protection in some cases would not at all be for others. The author reviews four positive cases and two doubtful ones, in which, in treatment for various conditions dermatologists had produced sterility and concludes that in some cases the testicles are so sensitive to the action of the x rays that doses which are ordinarily considered harmless may cause sterility. The protective devices ordinarily employed to shield the testicles may not be adequate enough to prevent harm.

C G SUTHERLAND M D

HEART AND VASCULAR SYSTEM

The Relation of the Shape of the Heart to the Shape of the Chest, with Special Reference to the Antero-posterior Dimension and the Morphology of Various Normal Heart Types. A Contribution to the Question of Accuracy of Ordinary Roentgenological Methods of Heart Measurement. H Roessler. Am Jour Roentgenol and Rad Ther, October 1934, 32, 464-486.

The material presented in this article is based on orthodiagraphic measurements of the heart and chest in 150 normal individuals (without sternal depression) with special attention being directed to depth measurements and ratios in an effort to more accurately estimate cardiac volume and thereby make roentgenologic measurements more anatomically accurate and clinically effective.

Measurements for the adolescent and adult groups showed no appreciable differences. Ratios between heart diameters, chest diameters, and heart-chest ratios were very similar for the two sexes. In men the average anteroposterior diameter was 8.7 cm, the normal range being 6.7 to 10.7, in women the average was 7.8 cm with a normal variation from 6.3 to 9.6. Expressed in percentages the ratio of heart depth to heart transverse diameter was 73.6 per cent for men and 71.8 per cent for women. The ratio of heart depth to the oblique heart diameter was 67.4 per cent for men and 64.1 per cent for women.

A close relationship was demonstrated to exist between the heart and chest: a flatter, broader, longer heart being found in the flat chest and a deeper, narrower, shorter heart in a narrow chest.

Chest measurement ratios showed the average

anteroposterior diameter (sternum to vertebra) to be 41.5 per cent of the average transverse diameter

When roentgen studies of the heart are made in one position only, the following possibilities may occur: two hearts of different volumes may give identical linear or area figures, or two hearts of equal volume may give different linear and area figures

J E HABBE, M D

An Aneurysm of the Pulmonary Artery, Georg Steiner, *Röntgenpraxis*, March, 1935, 7, 168-174

Only a few cases of aneurysm of the pulmonary artery have been described. There are two types of these aneurysms: (1) multiple aneurysms, which are very rare, and (2) aneurysm of the conus, which is sometimes very hard to differentiate from diffuse widening due to emphysema, mitral stenosis, pneumothorax, etc. A few cases of aneurysm have been described in which there was not only involvement of the main artery, but also of the secondary branches. One such case is described in detail. The heart was markedly enlarged, the pulmonary conus was very prominent and beside it there was another semilunar shadow which pulsed, on oblique films there was a very definite aneurysm of the pulmonary artery. In this case an open duct, possibly combined with a septum defect, was the cause for the aneurysm, the author believes.

HANS W HEFKE, M D

HIP JOINT

Coxa Magna, A Condition of the Hip Related to Coxa Plana, Albert B. Ferguson and M. Beckett Howorth, *Jour Am Med Assn*, March 9, 1935, 104, 808-812

The common type of coxa plana is a nutritional disturbance of the upper femoral epiphysis due to a certain degree of interference with its circulation by sclerotic changes about the femoral neck. The sclerosis is the result of a preceding inflammation at the joint. When there is a circulatory disturbance of this kind not sufficiently severe to produce coxa plana, there may be enlargement of the femoral head and neck without other noteworthy changes. These cases present the clinical features of coxa plana but are characterized roentgenographically by enlargement of the femoral head and neck instead of by flattening and irregular ossification of the head. This condition is designated coxa magna.

The physical signs in the authors' cases resembled those of coxa plana. Roentgenographic examination revealed a broadening of the femoral head and neck, varying from one sixteenth to five-sixteenths of an inch. The cartilaginous joint space was wide in four instances, normal in seven and thin in two. The capsule of the joint appeared distended in six hips and not distended in seven. The broadening of the head and neck tended to increase for a varying time, while the other changes tended to revert to normal.

The treatment of coxa magna should be rest in bed without immobilization and removal of foci of infection.

CHARLES G SUTHERLAND, M D

HODGKIN'S DISEASE (THERAPY)

Lymphoblastoma with Paraplegia and Prolonged Irradiation, L. F. Wheatley, *Jour Am Med Assn*, Feb. 9, 1935, 104, 460, 461

This is a report of a case of lymphoblastoma (Hodgkin's type) in a girl first observed at the age of twelve. At the age of nine she had mumps in the left parotid region. A year later, an enlarged cervical gland was removed from the same side. Still another year later there was a recurrence, and a biopsy at this time was reported as showing tuberculosis. Routine examination at the sanitarium to which she was sent revealed a mediastinal tumor, and a biopsy at this time revealed the lesion to be a slow growing lymphoblastoma; she was referred for radiation therapy. The mediastinal growth entirely disappeared following treatment at this time. Intermitting treatments controlled recurrences. After a six-year period she developed partial paraplegia. Heavy irradiation over the dorsal spine controlled the condition in that region for about one and a half years, she was apparently in a normal condition at the end of six months, when it returned, causing the death of the patient. An extradural mass was found at necropsy.

C G SUTHERLAND, M D

LEAD POISONING

Epidemiology of Lead Poisoning, A. J. Lanza, *Jour Am Med Assn*, Jan. 12, 1935, 104, 85-87

Inhalation and ingestion are the two routes by which lead gets into the system, and the first is the more important. In the main, industrial poisoning is due to inhalation and non industrial poisoning to ingestion. Water supplies conducted through lead pipes have been an important source of community poisoning. The greater the carbon dioxide content of the water, the more readily lead was carried into solution. Numerous instances have been reported of lead poisoning due to home fermenting and distilling of wines, beers, ciders, and similar beverages in utensils glazed with a lead compound. Lead was used to counterbalance a grinding wheel in a flour mill, with the result that the flour was impregnated with fine particles of metallic lead, poisoning a number of persons. Poisoning resulted from the metallic foil in which snuff was wrapped. The use of discarded storage battery cases for fuel resulted in several epidemics of lead poisoning. Lead poisoning from paint on verandas and railings where children played has been described. In Japan, the use of lead-containing toilet powders has caused widespread lead poisoning in both infants and mothers.

C G SUTHERLAND, M D

The Biochemical Behavior of Lead in the Body, Joseph C. Aub, *Jour Am Med Assn*, Jan. 12, 1935, 104, 87-90

In the last ten years, a great deal of work has appeared on the subject of the biochemistry of lead. In regard to absorption there is little new important evi-

dence The experience in industry confirms the laboratory finding that lead which is inhaled is far more toxic than lead which is swallowed The prevailing opinion has long been that lead is carried as an albuminate but experiments and blood studies have offered convincing evidence that lead is precipitated in the bones as the very insoluble tertiary lead phosphate and carried in the blood as the more soluble di lead phosphate In a chemical system as complicated as blood plasma an equilibrium of several chemical compounds is not unreasonable Any of these compounds might remain ionized and dispersed in the presence of plasma proteins If larger quantities of lead are inhaled swallowed or injected excretion does not maintain an equilibrium and lead becomes stored Once lead is absorbed there is a characteristic distribution in tissues which is approximately the same for inorganic, organic or colloidal lead, no matter what the route of absorption It is distributed throughout the viscera, but to the greatest extent in the liver, spleen, and kidneys, immediately following absorption After a few days, however, it gradually collects almost entirely in the bones The problem of treating lead poisoning is the problem of controlling the deposit and excretion of lead from this skeletal storehouse

If rapid deleading is to be avoided it is necessary simply to give a large calcium intake in the diet This lowers the body's demands on calcium stores, and the only excretion of bone calcium (and lead) comes from the normal metabolism of the bones Obviously, this is the method that should be used during any toxic lead episode

After the episode has subsided in the author's experience, a vigorous course of deleading is usually followed by a prompt recovery to normal health

C G SUTHERLAND M D

LEUKEMIA

The Differential Diagnosis of the Leukemic States, with Particular Reference to the Immature Cell Types Roy R. Kracke and Hortense Garver Jour Am Med Assn, March 2, 1935, 104, 697-702

Until the second decade of the twentieth century there were recognized only two types of leukemia myeloid, arising from the bone marrow, and lymphatic, having its origin in the lymphoid tissue The recognition of a third type of leukemia involving the monocytic cells has engendered new ideas concerning the origin and classification of blood cells All blood cells have their origin from the mesenchymal cell of the mesodermal layer in the embryo From this point opinions diverge in many directions

It is virtually impossible to distinguish between the various types of leukoblasts with ordinary staining methods or even with vital staining Cases of chronic leukemias can be diagnosed easily as well as acute forms provided the total white cell count is definitely increased, with a preponderance of blast cells The leukemic states in which the total number of white cells is normal or below normal offer considerable difficulty in diagnosis both clinically and hematologically

and are apt to be confused with various leukopenic diseases

The most reliable criterion for the diagnosis of any leukemia is a preponderance of immature cells regardless of the total number Studies on a large number of cases of monocytic leukemia that are filed in the Hematological Registry indicate that the chief cell type has its origin in the bone marrow and adds further evidence that monocytic leukemia is but an atypical phase of myelogenous leukemia

CHARLES G. SUTHERLAND M D

Leukemia Its Diagnosis and Treatment Nathan Rosenthal and William Harris Jour Am Med Assn, March 2 1935, 104, 702-706

Leukemia has heretofore been regarded as a disorder characterized by a persistent increase in the number of white blood cells According to the present concept of the disease however an increase in the number of white cells is not an essential diagnostic factor

The authors classify 455 cases seen in hospital and private practice over a period of fifteen years and discuss the blood picture symptomatic variations and differential diagnosis A typical case of leukemia, either acute or chronic is usually differentiated by the presence of an increased number of white blood cells as well as mature or premature leukocytes However difficulty in diagnosis may be encountered in cases of leukopenic leukemia in which the number of leukocytes is normal or profoundly reduced Such cases when admitted to the hospital, are sometimes diagnosed as pernicious anemia purpura hemorrhagica, agranulocytosis, subacute endocarditis splenic anemia or other disorders

Radiotherapy is the most satisfactory method of treatment of greatest therapeutic value in chronic myeloid and chronic lymphoid leukemia Radium in the form of surface application or packs is used only in the event that roentgen therapy is not available or in patients who cannot be moved from their homes

The marked radiosensitivity of leukemic tissue and the lability of the blood count necessitate extreme caution In general marked reactions should be avoided and rapid regressions of leukemic deposits should not be sought In the authors series the areas treated were the spleen in myeloid cases and palpable lymph nodes and spleen in the lymphoid cases Occasionally the long bones or the flat bones were irradiated but the response appeared to be somewhat slower The effect of roentgen treatment is measured by the degree of symptomatic improvement In favorable cases there is a rise in the hemoglobin and an increase in the red blood cells a response that occurs more rapidly in myeloid cases In lymphoid leukemias the improvement is not so marked After the first series of roentgen treatments the blood picture may return to normal particularly in chronic forms and it may remain so for a variable period—from a few weeks to nine months The symptomatic improvement however may be of longer duration Additional treatment in their cases proved less successful In time patients

become more resistant to the treatment and, as the disease progresses, do not tolerate it well

CHARLES G. SUTHERLAND M D

THE LUNGS

Results of X ray Chest Examinations Among 2,500 Workers in a Heavy Industry Louis M Warfield Industrial Medicine, June, 1935, 4, 302-306

Twenty five hundred workers in a large industry located in a small city near Milwaukee Wisconsin which employs 3,500 men and a few women, recently equipped a roentgen department and began a study of the chests of its employees. The plant has two foundries, machine shops, etc

It was decided that a single postero anterior film taken at 5 feet 75 to 80 K V 100 ma, $\frac{1}{10}$ second exposure would meet most requirements. If flat films proved inadequate, stereo sets were made.

In the two foundries 691 chests were examined, the men ranging from 18 to 80 years. Scattered cases of silicosis were found in several of the machine shops, but in every case the past occupational history revealed that the individual had worked in copper or iron mines for from 10 to 37 years. The silicosis cases found among the 2,500 examined (including 113 women) were found in the foundries, boiler shops, brass foundry and forge shop. The cases outside of the foundries were found to be very mild and not of any significance.

After examining over 4,000 chest films during the last 18 months the writer feels that the flat film is quite satisfactory.

The most striking comparison shown in these examinations is the evident difference between the lesions produced by silica inhalation in the foundry workers and in granite-cutters. The only comparable conglomerate lesions were those found in sand blasters and granite-cutters. *There were none of the massive infiltrations seen among the 2,500 workers of this series [Abstractor's italics]*

It is exceedingly doubtful if the most expert roentgenologist can make a certain diagnosis of the so-called first stage silicosis even if he has the occupational history of the subject of the examination. [Abstractor agrees with this and says 'Amen' to it]. It is well recognized that hilum shadows are so variable in size and density in normal lungs that opinions based upon hilum appearances are likely to be incorrect. The added criterion of the first stage namely 'more fibrosis than normal' is also a limber reed to hold up an opinion.

The only case of active tuberculosis seen was in a man 38 years old who applied for work in the foundry and who had been a core worker in other foundries for 18 years. He showed no evidence of silicosis. With pulmonary tuberculosis so widespread and with evidence of childhood healed infection in 100 per cent in this study it seems strange that none of the 691 foundry workers examined showed active tuberculosis. There is no evidence that tuberculosis in the presence of mild or moderately severe silicosis heals as it usually does in non silicotic lungs.

This raises the question of the accuracy of the widely accepted view that silicosis activates tuberculosis. Animal experiments seem quite conclusive, but we must bear in mind that, however carefully animal experiments are performed, conclusions drawn from these experiments can be true only for the animal treated in that particular way. One has no right to conclude that because animals react under artificially created conditions, humans will react similarly under natural and widely different conditions.

A further interesting observation is that increased linear markings and beading of the linear markings were not found in the silicotic lungs but in the lungs in which healed calcified nodules presumably due to tuberculosis, were present. Silicosis is probably not the cause of the increased linear markings, but tuberculosis is.

Individual predisposition plays an important part. One 76 year-old iron moulder (for 52 years) showed very mild silicotic lesions. Another (56 years old), who had worked in Michigan iron mines for 25 years and afterwards in a foundry for seven years, had lungs which showed only moderate nodular lesions. Another (51 years old) had been a moulder for 34 years with no lung signs of silicosis. A man of 47 has been a chipper of castings for 29 years, with lungs normal. One man, aged 80, a chipper for 22 years, had no lesions.

On the other hand four men between 20 and 39, all of whom had begun work before they were 18, showed very early signs of silicosis.

Of the 2,500 films examined, 2,355 were negative for silicosis. Of the 691 foundry workers, 562 were negative. Among the 2,500, there was one case of complete situs transversus, and three cases of eventration of the left leaf of the diaphragm. There was one case of bronchiectasis and one individual had a mass in the hilum which was thought to be malignant.

Examination of 2,500 flat films showed 527 men with some abnormal findings, the great majority of which were compatible with good health and ability to work. Of 691 foundry workers, 129 had demonstrable silicosis.

I S TROSTLER, M D

The Roentgenologic Diagnosis of Chronic Pulmonary Emphysema Walter W Fray Am Jour Roentgenol and Rad Ther, July 1934 32, 11-22

The roentgenologic findings in emphysema may vary considerably. Signs which have been considered of value are (1) increased space between the heart and sternum, which remains essentially unaltered during inspiration and expiration, (2) low flattened diaphragm with limited mobility, (3) increased prominence of pulmonary markings in the peripheral lung zone, (4) general increase in brilliancy of the lung fields, (5) diaphragmatic folds, and (6) irregular dilatations of bronchi after lipiodol injections. The writer made careful comparative studies of the fluoroscopic and radiographic findings of 52 normal and 52 emphysematous individuals, the radiographic data being obtained from routine postero-anterior and left anterior oblique films. The important roentgenoscopic findings

are (1) unchanged radiolucency of lung fields during the respiratory cycle, (2) clear definition of the diaphragm at the end of maximum expiration. The roentgenographic findings are more numerous and variable. One of the most reliable is that of a low "thoracic index" (a figure obtained from the two above mentioned films, by dividing the transverse diameter of the chest at the level of the base of the heart on the postero anterior film by the transverse diameter on the left oblique film). In the normal, this ratio varies from 0.96 to 1.26 (average 1.10) while in emphysema the range was from 0.85 to 1.07 (average 0.96). Thoracic flaring is another fairly constant sign. Low position of the diaphragm increased brilliancy of the lung fields, and peripheral lung markings were not found to be reliable signs in this series of cases.

J. C. HABBE, M. D.

Pulmonary Manifestations in Human Tularemia
A Clinical Study Based on 35 Unselected Cases
Staige D. Blackford. *Jour Am Med Assn*, March 16, 1935, 104, 891-895.

Pulmonary Manifestations in Human Tularemia
A Roentgenologic Study Based on 34 Unselected Cases
Vincent W. Archer, Staige D. Blackford, and James E. Wissler. *Jour Am Med Assn*, March 16, 1935, 104, 895-898.

Tularemia affected the thoracic viscera in a high percentage of cases which came to necropsy, this study demonstrates that pleuropulmonary infections are frequent in patients who recover from the disease. Clinical methods detected lung or pleural involvement in approximately half of this unselected series and roentgenograms revealed abnormalities in the chest in more than 90 per cent of these cases.

Chest films were taken in 34 of 35 cases at some time subsequent to the inoculation in 18 patients during the active stage of the disease, eight of these returning after recovery for further roentgen examination. Roentgenograms after recovery were made in 16 of the remaining cases. Seven showed pulmonary consolidation, seven peribronchial thickening, three pleural effusion and one nodular infiltration. The residual changes were (1) increased fibrosis and (2) an apparent increase in calcification.

CHARLES G. SUTHERLAND, M. D.

Is it Empyema or Collapsed Lung? Ephraim Korol.
Am Jour Roentgenol and Rad Ther August, 1934, 32, 198-205.

The roentgenologic recognition of the development of an empyema occurring in the course of a chronic lung disease presents great difficulties because of fibrosis, atelectasis, and adhesions usually being present. Five cases are presented to illustrate the great likelihood of suggestive clinical and roentgenologic findings not being confirmed by operative or postmortem studies.

Two special radiographic diagnostic procedures are recommended for this type of case. In cases in which the suspected empyema or atelectasis is apical, roentgenograms should be made in deep inspiration and deep

expiration. If the density is caused by fluid, there is no change in its appearance on these two films. If caused by atelectasis it enlarges and "brightens up" due to a relative inflation with forced expiration (Kreutzfuch's phenomenon). If the density is at the base, a special supplementary film should be taken with the subject lying on the good side for areas of atelectasis are generally inflated in the higher lung.

J. E. HABBE, M. D.

Exudates of the Pleura and Focal Pneumonias in Abdominal Diseases Ladislaus Udvardy. *Röntgenpraxis* December 1934, 6, 785-792.

Disease processes in the abdomen may and often do lead to secondary changes in the base of the lungs and in the pleura. The diaphragm has many lymphatics which allow the migration of such processes from the abdomen into the chest. If an infection spreads from the abdomen into the chest the costophrenic angle is usually obliterated by a small exudate and there are intensive broad long horizontal bands visible in roentgenograms of the chest which are usually situated just above the diaphragm. These shadows represent a fibrous pleurisy. The pleuritic changes are almost always on the same side as the primary disease in the abdomen. Processes in the mid abdomen (as, for instance, a pancreatitis) may cause pleuritic symptoms on both sides. Cases with typical roentgenologic symptoms are described: carcinoma of the ovary, carcinoma of the cecum, purulent cholecystitis, chronic abscess of the gall bladder, advanced cirrhosis of the liver, appendiceal abscess and pancreatitis. Sometimes there is not only a transmitted pleurisy, but also bronchopneumonia. The horizontal pleuritic thickening disappears after the primary disease in the abdomen has healed.

HANS W. HEFKE, M. D.

Silicosis and Primary Carcinoma of the Bronchus
Report of Case. M. James Fine and James V. Jaso.
Jour Am Med Assn, Jan 5, 1935, 104, 40-43.

This is a case report concerned with chalicosis or silicosis. The authors subdivide pneumoconiosis into (1) anthracosis (due to the inhalation of coal dust), (2) siderosis (following the inhalation of iron and steel dust) and (3) chalicosis or silicosis (resulting from the inhalation of stone dust).

The patient was referred to the chest clinic with a diagnosis of advanced pulmonary tuberculosis. He had been a stone cutter for 20 years and had abandoned his work three years before because of increasing dyspnea. On admission to the hospital, the dyspnea was severe enough to require oxygen therapy. The patient died within two months. Necropsy revealed a co-existent carcinoma and silicosis.

C. G. SUTHERLAND, M. D.

THE MEDIASTINUM

Mediastinitis Karl Kornblum and Leslie H. Osmond. *Am Jour Roentgenol and Rad Ther* July 1934, 32, 23-42.

This diagnosis is difficult to make and only by the

combination of the clinical and roentgenologic findings can any degree of accuracy be reached. The disease is either inflammatory or neoplastic in nature.

Anatomically, the mediastinum communicates with the neck, retroperitoneal tissues, areolar tissue between the parietal pleura and sides of vertebrae, the space between the ribs and parietal pleura anteriorly, lungs and region between pleura and lung. Thus complications of various sorts may arise, and the infection spread from the mediastinum to the communicating regions and *vice versa*.

Usually, the condition is secondary, and by extension, although also from trauma, metastasis, and hematogenous spread. It may be acute or chronic, diffuse or localized, suppurative or non-suppurative. The latter is rarely recognized. The acute suppurative may follow a foreign body in the esophagus, the trachea or bronchi. Chronic mediastinitis is not uncommon. It frequently follows pericarditis and results in adhesions between the mediastinum and pericardium. The most common cause is tuberculosis, syphilis, actinomycosis and Hodgkin's also occur.

The cardinal symptoms are cough, pain, and dyspnea, but many others may be present, in some, especially chronic, the symptoms may be absent.

Roentgen examination is the best means of detecting the disease, although considerable difficulty is encountered. Usually there is a bilateral general widening of the mediastinum. In the acute localized suppurative form, a fluid level, if examination is made in a sitting position may be seen in addition to the general widening. In the chronic, the contour is somewhat irregular and indistinct, and the trachea and bronchi may be distorted. Evidence of compression of the lung is usually present. The esophagus may show changes in its contour. Fluoroscopically, the heart is fixed in both phases of respiration, at times an upward tug of it being present on deep inspiration. The localized tuberculous form may show calcification.

S M ATKINS, M D

PARATHYROID GLANDS

Roentgen Therapy of Hyperparathyroidism. Edwin A. Merritt and Edgar M. McPeak. *Am Jour Roentgenol and Rad Ther*, July, 1934 32, 72-81.

Osteitis fibrosa cystica (von Recklinghausen's disease) is now known to be caused by hyperparathyroidism. Such other bone diseases as Paget's ankylosing polyarthritis, multiple myeloma and giant-cell tumor may also be of endocrine origin although apparently not due to pure parathyroid dysfunction.

von Recklinghausen's disease occurs most commonly in females between the ages of 30 and 60 years. The cardinal symptoms are pain, weakness, weight loss, loss of appetite, and constipation. Occasionally there is elevation of temperature, and postural abnormalities are the rule in late cases. Blood calcium is usually elevated and serum inorganic phosphorus decreased

with increase of both calcium and phosphorus in the urine, hence renal calculi are frequently found. The multiple areas of cystic thinning of the bones commonly involve the metaphyseal regions of long tubular bones, while the vertebral bodies show compression fractures.

While there are a number of cases on record of surgical cure of one or more of the parathyroid glands, there is no satisfactory medical treatment. The authors recommend radiation therapy over the parathyroids as a more conservative procedure, which may nevertheless prove equally as effective, particularly in view of the wide variation in the amount and location of the parathyroid tissue. Six cases of cystic bone disease with findings more or less characteristic of hyperparathyroidism have been treated by conservative radiation (using 140,000 volts, 6 mm Al filtration, 10 X 15 cm fields, exposures of 240 r per field measured in air, each of four fields including either side of the neck anteriorly, the upper thorax anteriorly and the neck posteriorly being exposed at intervals of three weeks between each series), with cure or definite improvement being obtained in every case. The authors have never encountered personally or found in the literature a case of tetany following roentgen therapy for any disease process in the neck, and therefore feel that the treatment can be recommended as being entirely free of danger and as being on the same rational basis as that of ovarian, pituitary, thyroid, or other internal glandular dysfunctions.

J E HABBE, M D

PEPTIC ULCER

The Treatment of Perforated 'Peptic' Ulcers. Hugh H. Trout. *Jour Am Med Assn*, Jan 5 1935, 104, 6-9.

This paper deals only with the acute perforating ulcer that demands immediate operation. Surgery offers the best hope of recovery. The type of closure is a somewhat different problem in each individual case. Drainage of the peritoneal cavity should be avoided if possible. Continuous gastric suction through a nasal tube has decreased the indications for an immediate gastro-enterostomy. Partial gastric resection is the operation of choice in those cases of perforation of the stomach or duodenum which are associated with massive hemorrhage.

C G SUTHERLAND, M D

RADIATION EFFECTS

Physical Aspects of Various Qualities of Radiation. Robert S. Landauer. *Am Jour Roentgenol and Rad Ther*, August, 1934 32, 235-238.

Draper's fundamental law of photo-chemistry states that only that radiation which is absorbed produces any chemical action. As a corollary, it can be stated that only that radiation which is absorbed produces any biologic action. Furthermore, it can be assumed

that in cases in which radiation is beneficial to tissue, the greater the quantity of radiation absorbed the greater the beneficial effect

The major premise of this article is that regardless of how "hard" the radiation, it is impossible to shoot through a lesion, and, conversely, the harder the radiation the larger the absorbed depth dose. Landauer points out that x-ray intensity measuring instruments whether used to determine surface or depth doses do not measure that radiation "passing through" but do measure the dose absorbed at the measured depth. Some workers would explain the difference in the erythema dose measured in roentgens for different qualities of radiation entirely on the difference in rate of administration while others believe that under certain conditions the effects of equal quantities of radiation of different wave lengths are different. Landauer has compared the roentgen per-minute output of the 200 K V mechanically rectified transformer, the 600 K V transformer and the radium bomb, and their respective depth doses and has found the 600 K V transformer to give the most efficient depth dose in the most economic interval of time.

J E HADDE, M D

ROENTGEN-RAY BURNS AND INJURIES

Burns Produced by Radio Short Wave and Ultra short Wave Therapy and Their Prevention. David H Kling. With an Additional Case Report of a Severe Burn by George O Berg. Jour Am Med Assn, June 1, 1935, 104, 1981-1984

Abstracts of the histories of six cases in which burns developed in the course of radio short wave and ultra-short wave therapy are given. Three had second degree burns and three showed third degree burns with extensive destruction eventually necessitating skin grafts. In experimental work burns were produced in rats, ranging from edema to gangrene and loss of ears, limbs, and tails.

The widely circulated assumption that the use of condenser electrodes in short and ultra short wave therapy excludes burns and simplifies the technique is a dangerous fallacy. Sufficient energy proper electrodes and distance from the skin absorption of perspiration and constant control of patient and apparatus are imperative in order to prevent damage and derive the benefits of short and ultra short wave therapy.

CHARLES G SUTHERLAND, M D

ROENTGEN-RAY THERAPY

The Roentgen Therapy of Tuberculous Lymphadenitis and Orchepididymitis. Bruno Faccini. Arch di Radiol, September-October 1934, 10, 574-581

From the excellent results obtained in these cases, Faccini is of the opinion that surgery should be abandoned for both of these diseases and that the method of choice is roentgen therapy.

E T LEDDA, M D

THE SPINE

Dislocations of the Cervical Spine. Some Predisposing Causes. Theodore P Brookes. Jour Am Med Assn March 16, 1935, 104, 902-905

Reviewing a series of 65 cases of traumatic dislocations of the neck the author was impressed with the presence of systemic predisposing causes in a certain small group. As a toxic predisposition, alcoholism headed the list. Among destructive bone conditions he classified tuberculosis and osteo-arthritis as direct causative factors and did not include them in the study of traumatic dislocations. Three cases developed in adults during treatment of other conditions. One he thought might be of non traumatic origin, weakened soft tissues permitting dislocation with a minimum of violence. Two patients suffered rotary dislocation of the atlas during treatment by cultists. In five cases in children during the prodromal stage of an illness careful examination revealed that a dislocation of one of the vertebra had resulted from a fall.

Roentgenograms, accurately taken and carefully interpreted will verify the clinical observations in a majority of instances. Routine roentgenograms call for three exposures: lateral of the cervical spine and two anteroposterior views of which one is taken through the open mouth to show the first two vertebrae. Frequently, additional oblique views are required to show the articular processes.

CHARLES G SUTHERLAND, M D

THE STOMACH

Peroral Gastroscopy, Including Examination of the Supradiaphragmatic Stomach. Chevalier Jackson and Chevalier L Jackson. Jour Am Med Assn Jan 26, 1935, 104, 269-274

There are three methods of gastroscopy: one by using an open tube, another by using a lens system, and a third by combining both the open tube and the lens system. Each of these methods has its uses and limitations.

The open tube is of the method required for the removal of foreign bodies and the taking of specimens of tissue for histologic examination. It has all the advantages of looking directly at tissues examined rather than at a lens projected or prism deflected image.

Lens system gastroscopy has the advantage that a much larger field of vision is available. The limitation is the danger of introduction of an instrument presenting no esophageal lumen ahead. This danger is obviated by the introduction of an open tube through which a lens system is passed.

Almost all the danger in gastroscopy is associated with the insertion through the esophagus, especially at the cricopharyngeal and diaphragmatic pinch-cocks. The watchword of safety is find the lumen.

The contra indications are few and examination is indicated in every patient with gastric symptoms for diagnosis unless there are over balancing contra indi-

cations Hematemesis is a strong indication for gastroscopy, a tentative diagnosis of hysterical gastric neurosis is a clear indication for the same, as is an uncomplicated gastritis

C. G. SUTHERLAND, M D

Roentgen Diagnosis of Carcinoma at the Cardia
William H Stewart and H Earl Illick. *Am Jour Roentgenol and Rad Ther*, July, 1934 32, 43-51

Cancer of the cardia of the stomach comprises about one-sixth of the cancers involving this organ, and is not suspected unless dysphagia is present when it is already inoperable. The technic of the roentgen examination of the cardia, the roentgen signs and the symptoms and differential diagnosis of cancer of this region are described. The roentgen signs listed are any dilatation of the lower esophagus, any abnormal retention of barium in the lower esophagus, barium passing through the esophagus in a continuous stream, narrowed esophagus and unchanging canalization through tumor, frozen mass from infiltration of lower esophagus mass visible in gas bubble or deformity of latter, distorted rugal pattern or visibility of mass by contracted lumen, barium forking over the mass, gastric hypermotility, esophageal antiperistalsis and increase in the width of the space between the diaphragm and the fundus.

The authors deplore the examination of the stomach by physicians whose sole roentgen training is the mere possession of a machine. They urge roentgen examination when gastric symptoms are present.

S. M. ATKINS, M D

TUBERCULOSIS (PULMONARY)

From Pathology to Epidemiology in Tuberculosis
Softening of the Caseous Tubercle and its Results
Esmond R Long. *Jour Am Med Assn*, May 25, 1935, 104, 1883-1888

The problem of softening of the caseous tubercle may justly be considered the key problem in tuberculosis. If caseous tubercles did not soften, the disease would be self limited and would die out with the end of the present cases, except for occasional cases dependent on unusual methods of transmission. The lung is infected by tubercle bacilli, cellular and subsequently caseous tubercles are formed and some of these soften. The softened caseous matter is discharged into the bronchioles and aspirated into other parts of the lung, with the production of new tubercles, some of which in turn soften or it is coughed into the outside world, where other people may be infected. Associated with the softening, an extraordinary multiplication of tubercle bacilli occurs. At the stage when the product of tuberculous infiltration first discharges into a bronchus it has its maximum infective power. Not before, nor again after, are tubercle bacilli to be found in the region concerned in the concentration coincident with softening. Softening occurs quite as commonly in the absence of leukocytes as in their presence. The fundamental nature of the process of softening is still unknown.

It is not equivalent to suppuration. Attempts to put it on an allergic basis have not been entirely successful.

Successful treatment of tuberculosis by lung collapse owes its favorable outcome as much to prevention of drainage of liquefying tubercles as to the obliteration of large cavities. Lung collapse, improperly applied, particularly with excessive pressure, even when obvious cavities are obliterated may result unfavorably through expulsion of highly infective liquefying matter into tributary bronchioles. The most appropriate lung collapse as far as the softening tubercle is concerned, is that which stops motion of the lung and partially or completely obliterates the small bronchiolar outlets from the liquefying masses.

CHARLES G. SUTHERLAND, M D

The Declining Death Rate from Tuberculosis in Children. An Analysis of Tuberculosis Deaths in Minnesota from 1915 to 1932. Ruth E. Boynton. *Jour Am Med Assn*, May 25, 1935 104, 1875-1878.

There is a great deal of interest both in this country and in foreign countries in the prevention of tuberculosis in infants by the use of the B. C. G. vaccine. Proponents of this method of preventing tuberculosis feel that the immunity produced by B. C. G. vaccine will reduce the incidence of the disease in infants and young children who are intimately exposed to tuberculosis, thus reducing the mortality rate in this age group.

In Minnesota, where B. C. G. vaccination has not been tried, tuberculosis mortality rates in children are lower and have decreased at a more rapid rate than that reported by Wallgren in Gothenburg, Sweden, with the use of the B. C. G. vaccine. The Minnesota rates are reviewed in a series of charts and tables.

The types of tuberculosis causing the greatest number of deaths in children in the order of their importance were tuberculous meningitis, pulmonary tuberculosis and miliary tuberculosis. The largest number of deaths from tuberculous meningitis occurred in children under five years of age, and from pulmonary tuberculosis in those between 10 and 15 years of age. The highest mortality rate from both types was found in the group under one year of age. The greatest percentage of reduction in mortality in both types is in children under one year of age.

CHARLES G. SUTHERLAND, M D

Tuberculosis among Employees of the Minneapolis Schools. Francis E. Harrington, J. Arthur Myers, and Ida Levine. *Jour Am Med Assn*, May 25, 1935 104, 1869-1874.

With a feeling that during the next five years nearly every physician in this country will be called on to take a part in actual examination of teachers and children for tuberculosis or will be consulted by parents and others concerning the advisability of or information regarding such examinations, these authors review their experiences in the survey of the Minneapolis schools.

Workers in other fields had found that children taught by teachers with open tuberculosis showed a much

higher incidence of positive tuberculin reactions than those taught by other teachers. Considerable preparation for such a survey was necessary, proper information had to be furnished various groups regarding its necessity. The procedure was the administration of tuberculin tests and the preparation of x ray films of the positive tuberculin reactors, in addition to those who refused the tuberculin test. All manner of objections to the test had to be overcome. Reports on tuberculin test readings and reports on x ray readings were made in writing to each individual concerned and forwarded under seal making them strictly confidential. The highest reading was 82 per cent positive out of 23 persons tested, the lowest, 10 per cent positive out of ten teachers tested.

The chief advantages of such a survey are. First, disease may be detected before it has produced significant symptoms and while it can be treated successfully in a short time, thus saving the teacher a long period of inactivity from work. Such cases by adequate treatment may be prevented from breaking down so as to be a menace to the children and other teachers. Thus, the environment as far as tuberculosis is concerned becomes much safer from the standpoint both of the teacher and the child. Second, compulsory examinations often lead to investigation on the part of the teacher so that she becomes informed concerning the contagious nature of tuberculosis. Many such teachers become enthusiastic workers in the tuberculosis control program. This should lead ultimately to the enlistment and the support of great educational associations, which will be a valuable acquisition to the forces against tuberculosis.

CHARLES G SUTHERLAND M D

Interpretation of Roentgenograms in Pulmonary Tuberculosis. Henry K Taylor. Jour Am Med Assn, March 10, 1935, 104, 898-900.

Serial roentgen studies of pathologic changes of superinfections and reinfections (secondary) in pulmonary tuberculosis reveal that lesions are either exudative or productive in character, from the earliest time that patients come under observation. These lesions have a tendency to heal. The end result of the healing manifestations in pulmonary tuberculosis demonstrable on the roentgen film, permits of a division into five types.

The exudative lesion terminates in one of three ways (1) It may completely resolve and leave no traces in the roentgenogram (2) it may resolve and leave a residual of a few fibrotic strands or (3) it may undergo caseation and cavity formation. The productive lesions present themselves in one of two forms (1) fibrotic strands with small nodules and (2) fibrosis with numerous small cavitations resembling a bronchiectasis.

The roentgenographic study of the pathologic changes in tuberculosis reveals a qualitative as well as a quantitative component. The pathologic mutations observed in serial roentgenograms reveal whether a

lesion is benign (running mild clinical course) or malignant (running a stormy course metastasizing and spreading). The malignant are the types that compel the use of collapse therapy. This information aids in determining prognosis and treatment.

CHARLES G SUTHERLAND M D

TUMORS (DIAGNOSIS)

The Roentgen Diagnosis and Treatment of Tumors of the Bladder. Their Serial Study with Pneumocystograms Showing Results of Treatment by Irradiation. George E Pfahler and Jacob H Vastine. Jour Am Med Assn, Feb 23, 1935, 104, 609-612.

Pneumocystography is harmless and painless and requires no great amount of paraphernalia. It can be used in conjunction with cystoscopy, or at times when cystoscopy cannot be performed. The technique is given in detail, also, the objections to the examination and the interpretation of the findings by this method are discussed. In the treatment of small benign tumors, the authors recommend preliminary irradiation and cystoscopic electrocoagulation, followed by an additional moderate amount of irradiation.

In dealing with large and definitely malignant tumors the family physician, the urologist, and the radiologist should co-operate in a general plan of treatment to obtain the best results.

The authors believe the treatment should be arranged with the purpose of overcoming the disease completely by irradiation. It may be necessary to destroy remaining tissue in some by electrocoagulation. As a result of irradiation one commonly succeeds in arresting the hematuria sometimes within a few days, but generally within a few weeks. In the more sensitive tumors one may expect the entire tumor to disappear.

By means of the pneumocystogram, the progressive reduction in size of the tumor may be measured.

C G SUTHERLAND M D

Blood Vessel Tumor of the Spinal Cord in a Boy Aged Nine Years with Special Reference to a New Diagnostic Syndrome. William C Black and Harold K Faber. Jour Am Med Assn, May 25, 1935, 104, 1889-1891.

These authors found record of 63 cases of blood vessel tumors and varices of the spinal cord. Of this number 10 per cent were purely arterial or presented an arterial component. The remaining 90 per cent were composed of about equal numbers of true neoplastic hemangiomas and of venous dilatations, the latter are not neoplastic formations but have been included in all reviews of the subject. Only one case of blood vascular cord tumor has been reported prior to the one the authors present in an individual under ten years of age. They report a case of intradural venous blood vascular tumor probably hemango-endothelioma with associated varices. The combination noted of the Froin syndrome a negative Queckenstedt test becoming positive after with-

drawal of spinal fluid below the lesion, and a peculiar distribution of iodized oil in droplets suggests that it may be pathognomonic of subarachnoid varices and vascular tumors of the cord large enough to obstruct the subarachnoid space

CHARLES G. SUTHERLAND, M D

TUMORS (THERAPY)

A Classification of Tumors from the Standpoint of Radiosensitivity Arthur U Desjardins *Am Jour Roentgenol and Rad Ther*, October 1934, 32, 493-499

The writer believes that the basic law of a specific range of sensitivity of each variety of cells in the body normal or pathologic, to roentgen rays or radium has not been as widely recognized and utilized as it should be. He emphasizes particularly the value of this basic law in the classification of various tumors, and states that in the future it is entirely possible that a more correct and satisfactory classification of given tumors will be accomplished by their reaction to radiation rather than by microscopic classification by pathologists. He recognizes full well that this specific range of sensitivity of different cells is not the sole factor determining the results of radiation therapy. It is dependent also upon blood supply and exposure to previous radiation, and there are, of course variations in reaction of different individual cells of the same type because of these cells being in different stages of metabolism. The lymphocyte, the metabolic cycle of which among human cells is the shortest, is the most radiosensitive, while the nerve cell, the cycle of which is the longest, is the most resistant to radiation.

Classifying cells according to their radiosensitivity from the most sensitive to the least sensitive, the writer offers the following classification: Lymphoid cells, polymorphonuclear and eosinophilic leukocytes, epithelial cells comprising (1) mucus secreting epithelial cells (2) basal epithelium, (3) alveolar epithelium and (4) epithelium of the tubules of the kidneys, endothelial cells of blood vessels, pleura and peritoneum connective tissue cells, muscle cells, bone cells, fat cells, and nerve cells. Thus, the epithelium of the skin stands about half way between lymphocytes on the one hand and nerve cells on the other.

Neoplasms are divided into three main groups: (1) the radiosensitive tumors the sensitivity of which is greater than that of skin (2) the moderately radiosensitive tumors the gross sensitivity of which approximates that of the skin and (3) radioresistant tumors, the sensitivity of which is less than that of skin.

Radiosensitivity, rate of metabolism and life cycle of cells appear to be closely interrelated.

In the radiosensitive group there are included the lymphoblastomas and lymphoepitheliomas, diffused endothelioma, embryonal carcinomas of the testis and ovary, giant-cell and multiple myeloma bone tumors, Wilms tumor of the kidney, basal-cell and transitional

epitheliomas, mucoid carcinomas of the intestinal tract, and hemangiomas.

In the moderately radiosensitive tumors are included the following: carcinoma of the uterine cervix, carcinoma (not adenocarcinoma) of the thyroid, epithelioma of the tonsil and pharynx, bronchus, lip, eyelids, mouth, tongue, and squamous type of skin, carcinoma of the breast and rectum, and chondrosarcoma of the bone.

The radioresistant group includes the fibromas and fibrosarcomas, adenocarcinoma anywhere except possibly in the cervix, carcinoma of the esophagus and stomach, hypernephroma, sarcoma of bone, melanopithelioma, mixed tumor of parotid, teratoma, neurofibroma, chondroma, lipoma, myxoma, and myxosarcoma.

In general, the radiosensitivity of metastases corresponds to that of the primary lesion, hence the diagnostic value of the therapeutic test may still be commonly applied to the secondary deposits when the primary tumor cannot be localized.

J E HABBE, M D

Bone Tumors and Irradiation Louis C Kress *Canadian Med Assn Jour*, June 1935, 32, 651-654

Kress evaluates irradiation in the treatment of bone tumors in a short systematic discussion of the various important types of bone pathology. The radiosensitivity of each is briefly considered and in cases in which therapy is satisfactory a technique is outlined. Among the tumors considered are, giant-cell tumor, osteitis fibrosa cystica, Paget's disease, the various types of sarcoma and metastatic carcinoma.

W A SODERMAN, M D

Modified 'Coutard' Roentgen Therapy James M Martin and Charles L Martin *Jour Am Med Assn*, Feb 23, 1935, 104, 605-608

Experienced radiologists discovered long ago that the actual cure of carcinoma requires the administration of from 5 to 10 erythema doses of x rays, and even more in some instances. It has been their practice to use from 5 to 12 erythema doses as an effective treatment for squamous-cell carcinoma of the skin for more than ten years. They used the so-called 'carcinoma dose' with the hope that the shorter wave lengths might possess some unknown properties that would compensate for the reduced dosage. Such did not prove to be the case in their experience.

High voltage therapy is used principally in treating tumors situated beneath normal structures, and investigators have made many attempts to increase the tumor dose without materially increasing the effect on the normal tissues, in other words, they have tried to increase the selective action of the rays. In America, this activity has been directed for the most part toward the production of huge tubes and machines operating at higher voltages and producing much shorter wave lengths. In Europe investigators have been more interested in changes in intensity (roentgens per minute),

and in the time consumed in administering radiation. Results possessing greater promise have been obtained by this method.

The authors review the Coutard technic and point out that the chief objection to it is the amount of time involved in its administration. They describe in detail a modification of the Coutard technic in which an economy of time is brought about through a reduction in filter from 2 mm. of zinc to 0.75 mm. of copper. Contrary to the belief of many, this produces only a slight change in the wave length so long as the voltage remains the same. They have found this to be apparently efficient and much less time-consuming than the French procedure.

C. G. SUTHERLAND, M.D.

THE UTERUS

Radiation Therapy in Cancer of the Cervix. William P. Healy. Canadian Med. Assn. Jour., June 1935, 32: 647-651.

As a guide in planning treatment of cancer of the cervix, Healy uses the following clinical classification: (1) Early cases—disease limited to the cervix. (2) Borderline cases—moderate parametrial involvement. (3) Advanced cases—extensive involvement of the parametria and vaginal vault. (4) Very advanced cases—frozen pelvis with or without vesical or rectal fistula in which only palliative treatment or nothing at all can be attempted.

Group 1 is favorable for cure and from 50 to 60 per cent should show a five year cure. Radium can be applied at once without risk to the lesion followed by deep x-radiation. Groups 2 and 3 constitute from 75 to 80 per cent of all the patients. The cervical lesion is usually extensively ulcerated, infected and necrotic. It is unwise to apply radium immediately without preliminary treatment. In 3,000 cases the best results with least risk to the patient were obtained by giving deep x-radiation first and withholding radium until definite improvement and response to x-ray was observed, as shown by shrinkage in size of the lesion, disappearance of soft necrotic tissue and replacement with a healthy appearing surface. Often the primary lesion showed complete surface healing before any radium was applied. Group 4 if treated at all received deep x-radiation and occasionally small applications of radium.

The comparison of results with those of others showed little variation. This led Healy to an improved method of radiation for the parametrial metastases. The dosage of effective radiation was increased by reducing the amount given at each treatment, increasing the number of treatments and adding two fields, six in all. This technic increases considerably the amount of effective radiation distributed throughout the parametrium and it is hoped will inhibit metastasis. The series with the improved technic is not large enough to evaluate as yet.

W. A. SODEMAN, M.D.

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ORAL CHOLECYSTOGRAPHY EVALUATION OF THE METHOD AND SUGGESTIONS FOR A NEW NOMENCLATURE¹

By EUGENE P. PENDERGRASS, M.D., and PHILIP J. HODES, M.D., Philadelphia

From the Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia

IN order to evaluate the accuracy of oral cholecystography, we have reviewed the radiographic findings in a group of patients studied after the oral administration of sodium tetraiodophenolphthalein and in whom the findings were subsequently checked at operation.

TECHNIC

The oral method for the administration of the dye has been used routinely in the University Hospital since the test was first employed. In rare instances, for confirmation, the intravenous method has been utilized. With a light fat-free evening meal the patient is given 60 grains of sodium tetraiodophenolphthalein dissolved in distilled water and mixed with grape juice. This is followed in one-half hour by two drams of paregoric in order to control catharsis. Paregoric has not been given sooner because it is known to retard the emptying of the stomach, which might readily delay the absorption of the dye. This method has been described by Kirklin (5, 6) and needs no further description except to say that during the last eighteen months we have limited the routine examinations to two exposures, one made sixteen hours after the dye had been given and the second one-half hour after the fatty meal. Frequently it has been necessary to make

additional exposures and, because of this, the patients have been kept in the department during the examination.

Some radiologists are in the habit of giving fat in the meal accompanying the dye. They believe that the fat will cause the gall bladder to empty completely before absorption of the dye, thereby increasing the amount of liver bile entering the gall bladder after absorption of the dye which would theoretically increase the chances for visualization. Kirklin (5, 7) tried this several years ago and found that it decreased the accuracy of the test by almost 25 per cent.

Levene and Whitaker (8) have stressed the value of taking at least one large (14 X 17) film, to include the entire abdomen during the examination, a procedure which we have always practised. We would like to emphasize the importance of this detail for the following reasons. In the first place, one can never be certain of the position of the gall bladder. We have had at least two patients in whom the gall bladder was on the left side and would have been missed if the large survey film had not been taken. More important than this possibility for error is the knowledge we have gained concerning the other organs in the abdomen. It is well known that many other diseases present symptoms not unlike those described in cholecystitis. Among such diseases may be included (a) nephrolithiasis,

¹ Read before the Philadelphia Roentgen Ray Society, January, 1935.

(b) chronic pancreatitis, (c) tabes mesentericus, (d) abdominal purpura, (e) adrenal tuberculosis, (f) calcification within adrenals, (g) hepatic and subhepatic infections, (h) diaphragmatic hernia, (i) abdominal aneurysms, (j) prolongations of calcified "cold abscesses," (k) pentostoma denticulatum, (l) diseases associated with enlargement or decrease in the size of the liver, (m) and retroperitoneal malignancy. These are some of the conditions to which the radiologist's attention may be drawn during the routine examination if the survey film is employed and the diaphragm included in the examination. During the last few years we have diagnosed all of these conditions in patients sent to us with suspected gall-bladder disease.

STATISTICS

The patients included in this study were those who had been operated upon for cholecystitis and in whom the Graham-Cole test for evidence of gall-bladder disease had been employed prior to operation. In each patient a radiological opinion had been expressed, based upon the cholecystographic study, and our statistics are a means of judging our diagnostic accuracy.

The first group of 351 patients was studied during the years 1926 to 1932, inclusive. Of these, a radiographic diagnosis was given in 342, since in nine patients the examination was considered unsatisfactory. Of these unsatisfactory studies, four were in patients who had breathed during the roentgen exposure, one in a patient who had vomited the dye, two in patients who had had diarrhea, and in one case the films were unsatisfactory as a basis for expressing an opinion. All of these patients were subsequently operated upon and we were able to compare the operative with the radiographic findings in each individual case. The radiographic conclusion was correct in 320 patients, a diagnostic accuracy of 93.6 per cent.

The second group included the patients studied during 1933. We have chosen the interval 1932-1933 as the dividing line be-

cause we have been more careful in our technic since that time, not hesitating to repeat examinations in cases in which any question arose as to whether the dye had been given or retained, or in which the films were not technically perfect. There were 75 patients in this group. Of these, 72 had roentgenographic diagnoses and in three the examination was considered unsatisfactory, two having vomited the dye and the third showing no evidence of dye in the intestinal tract at the time of the examination. In this series of patients the radiographic conclusions were correct in 70, or 97.2 per cent of the patients in whom a diagnosis was made.

If the patients studied in both groups were united into one group representing all of the patients operated upon for gall-bladder disease and in whom previous cholecystography had been performed from 1926 to 1933, inclusive, the diagnostic accuracy would be 94.2 per cent. In most of the instances in which we erred the error was in diagnosing "functioning gall bladder" in patients who later were proven to have gall-bladder disease. One patient in whom the diagnosis of "abnormally functioning gall bladder" had been made was found to have chronic appendicitis and no evidence of gall-bladder disease. The bile was not examined in this patient.

Recently Kirklin (7), in reporting his gall-bladder statistics for 1932, reported diagnosing about 70 per cent of the stones found at operation. We were able to indicate the presence of stones in only 27 per cent of the patients in whom stones were found at operation. After realizing how frequently we had been missing gallstones we tried reading more into the films, with the result that we made frequent mistakes. Since then we have once again become more cautious, and hesitate to make the diagnosis unless there is good evidence of their presence and collections of overlying gas can be excluded. The danger seems to be in interpreting too much, rather than not enough, in patients in whom there is abnormal gall-bladder function.

Calcification of the gall-bladder wall, so-

called "porcelain gall bladder," recently described by Blatter (1), was diagnosed twice and the diagnosis was confirmed later at operation. Three patients had carcinoma of the gall bladder and all three had abnormally functioning gall bladders. Only one patient had a gall-bladder papilloma at operation, the diagnosis was not made radiographically. An abnormally functioning gall bladder with "milch calcium" was found in two patients.

COMMENT

We have found the oral method for dye administration eminently satisfactory in the diagnosis of gall-bladder disease. Our diagnostic accuracy for the entire period was 94.2 per cent. Kirklin (7) reported slightly better results in that during 1932, of 445 patients with positive cholecystographic studies, 439, or 98.6 per cent, had cholecytic disease at operation. It may be that the intensified oral method for dye administration, recently advised by Stewart and Illick (18) and Golden (17), will still further reduce the diagnostic error.

PITFALLS IN CHOLECYSTOGRAPHY

It is well known that patients may develop diarrhea during the examination, which results in deficient dye absorption and faulty roentgen interpretation. We know that paregoric, given in the manner we have described above, will control diarrhea in these patients. Some patients vomit the dye, which makes it still more difficult to tell whether there has been sufficient dye absorption or not. In 1931, Delario (2) found that from 60 to 70 per cent of the dye was excreted by the liver and large bowel, and that from 5 to 10 per cent was lost in the urine and feces. He pointed out that in most instances one can obtain an idea of the quantity of the dye that has been absorbed by observing the character of the dye that may be seen in the intestinal tract. The coarse granular dye usually seen may be interpreted as the dye that was precipitated and therefore not

absorbed, whereas the fine powdery and homogeneous dye represents the dye that has been absorbed and excreted by the liver and large bowel. Many errors in interpretation may be avoided by this simple observation. We insist upon visualization of dye in the bowel before rendering an opinion of an "abnormally functioning gall bladder." We have had a number of patients with cardiac disease who, during compensation, gave evidence of the normal gall-bladder concentration of sodium tetraiodophenolphthalein but who, during a period of severe decompensation, showed no shadow when the method was repeated. This variation in results in the same patient has been attributed to the presence of passive congestion in the liver during decompensation, resulting in the decreased liver function at that period. This explanation may in part explain the findings, but it is possible that decreased absorption from the small intestines may be a major factor of poor visualization in such individuals. However, we have had many patients with severe cardiac disease in whom the gall bladder gave evidence of concentration of the dye.

Mann (9) demonstrated the failure of gall-bladder visualization in women well advanced in their period of gestation. Thyrotoxicosis and severe anemia may sometimes be factors in poor gall-bladder concentration also. We recently studied a patient who showed no concentration of the dye on three occasions and who, at operation, was found to have a duodenal ulcer and no evidence of gall-bladder disease. It is well known that colitis rather frequently causes a failure of the gall bladder to visualize after the administration of sodium tetraiodophenolphthalein, while at a later period, when the colitis is improved, the gall bladder may be well visualized.

Pimelli (10) recently published some work on the elimination of tetraiodophenolphthalein in diabetics. He found that diabetics concentrated the dye much faster than normal individuals. The maximum opacity was reached in from two to two and one-half hours after the administration of

the dye intravenously Emptying began in these patients in from three to seven hours and was complete in from twelve to sixteen hours If this be true, it is possible that the dye may be concentrated and evacuated before the radiologist begins his examination, when using the usual technic in diabetics

WHY DOES THE GALL BLADDER FAIL TO VISUALIZE?

Gall bladders fail to become visualized after the proper administration of sodium tetraiodophenolphthalein when—

- (1) There is delayed gastric emptying or faulty absorption from the small intestine,
- (2) The liver is unable to excrete the dye,
- (3) The cystic duct is obstructed,
- (4) The sphincter of Oddi mechanism is incompetent,
- (5) Damage of the gall-bladder wall has occurred

In 1931, Johnston (3) demonstrated that the rate of absorption of sodium tetraiodophenolphthalein through the gall-bladder wall was so slow that it did not seem possible for absorption to explain the rapid changes occurring in clinical cholecystography At the same time Ravdin and Morrison (11), demonstrating the contractile power of the gall bladder, concluded that concentrated bile left the gall bladder by way of the cystic duct Later, Pendergrass and Ravdin demonstrated this in the human Still more recently, Ravdin *et al* (12, 13, 14) showed that the damaged gall bladder failed to cause the alteration in the anion-cation concentration of liver bile such as occurs in the normal viscus With increasing damage of the gall-bladder wall, there was an increasing fall in the concentration of the bile salts and a rise in the chlorides of the gall-bladder bile, while in the normal viscus bile salts are concentrated and chlorides absorbed With these data, and the knowledge that there exists a reciprocal innervation between the gall bladder and the sphincter mechanism at

the end of the common duct, one may say that if the gall bladder fails to visualize, it is due to one of the five mechanisms outlined above

One would hardly expect to see a well defined gall bladder in a patient with well advanced acute yellow atrophy of the liver, or even in patients with severe hepatitis The failure of the gall bladder to visualize when the cystic duct is obstructed as the result of stones, adhesions, or pressure, needs no explanation

In explaining the failure of the gall bladder to visualize in the presence of duodenal ulcer or colitis, the observations of Smith and his associates (16) at the University of Iowa are of some interest These workers found that when the colon was irritated the gall bladder contracted This would prevent the normal filling of the viscus A similar result may occur in certain patients with duodenal ulcer

Ravdin and his associates (15) demonstrated that under normal conditions the gall-bladder wall absorbs from 3 to 7 c c of saline per hour, thereby producing bile concentration In disease, however, this absorption does not take place, and in some patients the fluid actually pours into the gall-bladder lumen, thereby producing a reversal of function Under such conditions liver bile containing a normal amount of sodium tetraiodophenolphthalein may be still further diluted when it reaches the gall-bladder lumen These factors may be applied to the failure of the gall bladder to concentrate tetraiodophenolphthalein and its lack of visualization in disease

NOMENCLATURE

For years, radiologists, clinicians, and physiologists have questioned the propriety of the radiologist making an interpretation such as "normally functioning gall bladder" and "non-functioning gall bladder" They have felt that we fulfill our province when we state that the gall bladder is functioning They feel just as strongly that we overstep our province when we state that the gall bladder is not functioning in view of the fact that it is

fairly well established experimentally that the gall bladder maintains some function, no matter how diseased it may be. Because of this criticism, which we feel is justifiable, we wish to offer the following nomenclature for reporting cholecystographic studies. It would be rather ideal for radiologists to establish some standard which could be universally used and understood by the medical profession.

I "*Functioning Gall Bladder*"—Such an interpretation would include those gall bladders in which there was good concentration of the dye and good emptying after the fatty meal.

- (a) "*Functioning Gall Bladder with Stones*"—Such an interpretation would include those gall bladders in which there was good concentration of the dye, good emptying of the fatty meal, but in which stones could be identified.
- (b) "*Functioning Gall Bladder with Mural Growth (Papilloma)*"—Such an interpretation would include those gall bladders with good concentration and emptying but in which, after changing position, the filling defect remains constantly in the same position.
- (c) "*Functioning Gall Bladder with Adhesions*"—Such an interpretation would include gall bladders that showed good concentration and emptying but which, due to their peculiar contour or location, indicate pericholic adhesions. This diagnosis is difficult but is included to make the classification complete.
- (d) "*Functioning Gall Bladder with Anomalies*"

II "*Partially Functioning Gall Bladder*"—Such an interpretation would include those gall bladders which did not show adequate dye concentration nor ability to empty.

- (a) "*Partially Functioning Gall Bladder with Stones*"—Such an interpretation would include those gall bladders which did not show adequate

dye concentration nor emptying and in which gallstones were identified.

- (b) "*Partially Functioning Gall Bladder with Anomalies*"

III "*Abnormally Functioning Gall Bladder*"—Such an interpretation would include those cases in which there was no gall-bladder visualization, or in which the gall bladder increased in size during the examination, thereby indicating a reversal of flow.

- (a) "*Abnormally Functioning Gall Bladder with Stones*"—Such an interpretation would include those cases in which there was no gall-bladder visualization but in which opaque calculi were discernible. Stones could be classified as "non-opaque" and "opaque."
- (b) "*Calcified Gall Bladder*"
- (c) "*Abnormally Functioning Gall Bladder with Anomalies*"

CONCLUSIONS

- 1 Oral cholecystography is adequate for routine gall-bladder study.
- 2 Certain pitfalls in the proper interpretation of the Graham-Cole method exist. By recognizing the sources for error, one may attain a high degree of accuracy in the examination.
- 3 Gall-bladder visualization and failure of visualization may be partially explained on purely a physiological basis with the experimental data now available.
- 4 A new nomenclature for reporting the results of the Graham-Cole procedure is outlined in the hope that it may help to standardize the various terms now in use.

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PRIMARY RESULTS OF TELERADIUM TREATMENT IN CANCER OF LARYNX AND HYPOPHARYNX¹

AT THE RADIOLOGIC CLINIC OF THE UNIVERSITY OF LUND, 1931-1933

By LARS EDLING, M D, *Lund, Sweden*

CONSIDERING the very abundant literature of these last years on radiotherapy of laryngeal and pharyngeal tumors, it would seem a little pretentious to add a new paper on this theme to the many existing, especially as the material here dealt with is rather limited and has been observed for a relatively short time. The chief reason for my taking up this topic at the IV International Congress of Radiology is, however, that I have used the teleradium, not the roentgen rays, in treating my material, which could perhaps be of some interest from the point of view of comparison of these two methods.

Since 1930 the Radiological Clinic of Lund has had at its disposal about 2 grammes of radium element, 1,220 milligrammes being particularly afforded by the Gustavus V Jubilee Foundation for teleradium treatment. This quantity is divided in 24 tubes of 50 milligrammes each and put into the radium gun constructed by Sievert.² For the details of this instrument, I refer to the author's description, only mentioning here that it may be moved by screw-gears in all directions and that it has a lead protection at least 2.5 centimeters thick. In our apparatus the radium cassette is placed at a distance of 5 centimeters from its orifice, and the circular field of treatment also has a diameter of 5 centimeters. The radium quantity being relatively small, we have chosen a filter of only 2 millimeters of lead equivalent. The surface intensity in the center of the radiation area has been defined by Sievert³ to about 35.5 Imc.⁴ Concerning the

radiation intensity in the field periphery and in different depths, the diagram of Figure 1 may give information.

Because of the small diameter of the radiation area of the gun and in order to avoid an overcharging of the skin with gamma rays, one must apply this instrument to several fields designed close to one another, the lead mantle of the gun affording a satisfying protection against lapping over at the surface. On the contrary, such a lapping over in the depth is attained by slightly tilting the gun from different directions or by irradiation also from the opposite side of the neck. Tumors located at a depth of from 3.5 to 4.5 centimeters, as is the case with most throat tumors, may be effectively treated, therefore, by the depth intensity existing, and with an economical use of radiation. With tumors of the larynx and hypopharynx, the depth dose according to the diagram amounts to from 35 to 40 per cent. With tumors of a deeper site, *e.g.*, those of the epipharynx, a more powerful radium intensity and a greater focal distance would be desirable.

As above mentioned, in treatment of laryngeal and hypopharyngeal tumors the radium fields should be designed on different sides of the neck in order to get the irradiation effect as homogeneous as possible. This technic must be adapted to the individual case, and as far as my own material is concerned, it has undergone several changes with increasing experience on my part.

In cases of laryngeal ("intrinsic") cancer, I generally give one field over the larynx

by 1 gr. radium filtered through 0.5 mm. platinum only, at a distance of 1 cm., the radium preparation being so small that the source may be considered as a point

¹ Presented before the Fourth International Congress of Radiology, Zürich, July, 1934.

² Acta Radiologica, 14, 197.

³ Acta Radiologica, 12, 300.

⁴ One Imc expresses 0.001 of the intensity produced

from the front and two from the sides and, in addition, two more fields a little posteriorly, one on each side. Metastases from 1,900 to 3,000 Imc -hours. The situation of the tumor being more extensive in such cases, it is often more difficult to

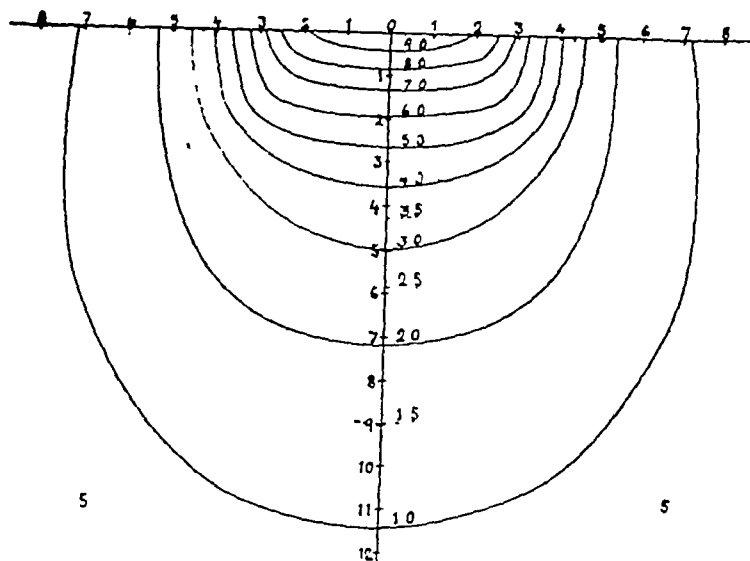


FIG 1

being rare in such cases, it is unnecessary to extend the irradiation to other parts of the neck. The total radium quantity given generally has varied between 52,000 and 90,000 milligram-hours (1,400-2,500 Imc -hr surface intensity), the lateral fields receiving somewhat heavier doses than the anterior one in order to prevent an over-irradiation of the larynx. The total depth dose may be calculated as about from 700 to 900 Imc -hours.

With cancer of the *hypopharynx* ("extrinsic" laryngeal cancers included), metastases very commonly are to be felt in an early stage of the illness, and often the deep-seated glands of the neck, although not yet palpable, are also invaded. Accordingly I generally use one anterior field, two on either side of the neck, one above the other, and eventually two additional posterior fields. On account of the very marked malignancy of these tumors, the total surface intensity here should be somewhat higher than in cancer of the larynx. In my cases I have given from 70,000 to 100,000 milligram-hours, corresponding to

estimate the depth dose but on an average it might be calculated at from 800 to 1,100 Imc -hours.

Generally we have given treatments every day, each of two hours' duration. The patient is lying on a comfortable sofa, the seat of which is movable on ball-bearings and provided with a contrivance for fixation. A pillow under the patient's shoulders stretches his neck backward as much as possible, and during lateral irradiations the head is turned sidewise. An exact fixation is maintained by sandbags. By means of the screw-gears of the gun and the mobility of the seat it is possible to obtain a very exact position, which must, however, be repeatedly checked during treatment.

As a daily radium dose is administered whenever the strength of the patient allows it, we could with the above amount of radium give 4,880 milligram-hours a day (the corresponding surface intensity being about 140 Imc -hours). With this dosage the irradiation usually lasts during a period of from 16 to 24 days, treatment being given

day and night, even on Sundays. Most patients stand this therapy without any difficulty. Nevertheless, *general symptoms* due to the treatment frequently occur, especially during the latter period of irradiation. There will appear in a great many cases general exhaustion, sometimes nausea or vomiting. With certain patients this may occur in an early stage of the treatment. On the whole, however, these symptoms seem to be milder and also of a shorter duration than in protracted roentgen treatment.

I am now proceeding to the *local effects* of telradium treatment. In many respects they bear resemblance to those of the fractionated roentgen treatment, but usually appear in considerably milder forms, at least as far as the subjective troubles of the patients are concerned. This must be owing to the more limited fields of irradiation and the lesser depth effects of telradium. To be sure, the reaction of the mucous membranes ought to be the same as in the Coutard treatment, *viz.*, an epithelitis with fibrinous exudation. With telradium, however, it is limited to the region of the hypopharynx and larynx only, what makes the swallowing less difficult and the throat troubles not so protracted as in roentgen treatment. Concerning the reaction of the skin, it does not seem necessary, at least with the dosage hitherto employed, to carry it as far as an exudative epidermitis. In fact, this grade of reaction is often missing in my cases, the skin changes generally being confined to a reddening followed by desquamation and eventually by patches of scabby character. Probably this is owing to the radium effects being distributed over several small fields and consequently not attaining the same intensity in the superficial layers as is the case with the large roentgen fields. These skin reactions, therefore, subside with relative promptness. Such subjective troubles as hoarseness, dry feeling in the mouth, and abnormal taste sensations do occur also in telradium treatment, it is not unusual for the last two

named to persist for rather long periods, sometimes for five or six months.

The histologic structure of the special tumors, in accordance with the opinions of Regaud and his school, is considered to be of very great significance from a prognostic point of view. Unfortunately the pathologic statements as to my material have not been detailed enough to be of any great worth in this respect, on which account it would seem of no use entering into further particulars on this phase. Only so much ought to be stated: among nine cancers of the inner larynx, one is a squamous epithelioma of the skin type and two are of the mucous membrane type, with predominant formation of basal cells. Among the cancers of the hypopharynx, there are two epidermoid tumors of the skin type, two of the mucous membrane type, and two more that may be characterized as undifferentiated cancers of a semi-epidermoid or anepidermoid type. In the remaining cases we have only the diagnosis of squamous or unclassified cancer. Moreover, this material is far too limited to allow any positive conclusions concerning the relations between the pathologic structure of the tumors and their radiosensitivity.

Tables I and II present a synopsis of my material in the two main groups.

(A) *Intrinsic Cancers of the Larynx* (Table I) — Eight cases have been treated and in one (Case 7), treatment was declined because of the bad condition of the patient and the progression of the tumor (destruction of cartilage).

Among the eight cases treated there are five living and symptom-free (October, 1934) in a very good condition after $3\frac{1}{4}$, $1\frac{3}{4}$, $1\frac{1}{2}$, $1\frac{1}{2}$ years, and 10 months, respectively. In Case 1 there appeared, a year and a half, after treatment, a small local recurrence, which was immediately removed by a laryngofissure and electroendothermy. Since then, this patient has been symptom-free. In the remaining cases no complications have been observed. In all, the laryngeal functions are very good.

TABLE I—CANCER OF THE LARYNX, LUND, 1931-1933

No	Name	Localization of tumor		Radium therapy dosage	Primary results		Subsequent course		Recurrences	Duration of life after beginning of treatment—final results
		Primary tumor	Metastases		Primary tumor	Metastases	Primary tumor	Metastases		
1	P O	Right vocal cord posterior wall of larynx		Teleradium 90 000 mg hr	Symptom free		Recurrence after 1 year and 6 months		Laryngofissure electro endo thermic symptom free	Three years and 6 months symptom-free
2	G S	Right ventricular ligament (arytenoid region)		Teleradium 70 000 mg hr	Symptom free		New tumor on opposite side after 2 years		Not treated died 4 months later	Two years and 6 months dead
3	G A.	Right vocal cord ventricular ligament and arytenoid region		Teleradium 80 000 mg hr	Improved symptom free	not	Recurrence after 6 months		Perichondritis surgical treatment later	Nine months dead
4	B H.	Bilateral infiltration of larynx recurrence after extirpation of cancer of vocal cords		Teleradium 52 000 mg hr 1 350 r	Improved symptom free	not	Recurrence after 5 months		Perichondritis surgical treatment Died 1 month later	Six months dead
5	N J	Left vocal cord		Teleradium 88 000 mg hr	Symptom free					Two years symptom free
6	O S	Right vocal cord		Teleradium 73 000 mg hr	Symptom free					One year and 6 months symptom free
7	S B	Large tumor filling out interior of larynx		Not treated because of destruction of cartilage and chondria						
8	D H	Right vocal cord and ventricular ligament		Teleradium 68 000 mg hr	Symptom free					One year and 4 months symptom free
9	B Z	Left vocal cord		Teleradium 58 000 mg hr	Symptom free					One year symptom free

In addition to the above-named, there has been one more case primarily (symptom-free, No 2) After two and one-half years, however, this patient presented a new-growth of the opposite arytenoid region On account of an old syphilitic infection and alcoholism, his chances of being restored to health by renewed treatment were very poor, and so this was not tried He died three months later of his disease

In Case 3 the tumor did not completely disappear, fixation of the vocal cords and swelling of the arytenoid region persisting Six months after treatment the patient developed a recurrence, with perichondritis, that caused his death in two months In Case 4 the tumor treated was a suspected local recurrence of a cancer of the vocal cords that had been removed in another hospital by extirpation of the cords On account of this previous operation, I did not dare to give this patient a sufficient radium dose, fearing that a perichondritis would follow This man was free from evidence of his disease only for some months, then another recurrence appeared, accompanied by perichondritis, so that a tracheotomy had to be performed He died from erysipelas and meningitis, and the autopsy proved the correctness of the cancer diagnosis

TABLE II—CANCER OF THE HYPOPHARYNX, LUND, 1931-1933

No	Name	Localization of tumor		Radium treatment dosage	Primary results		Subsequent course		Recurrences		Duration of life after beginning of treatment—final results
		Primary tumor	Metastases		Primary tumor	Metastases	Primary tumor	Metastases	Treatment and its results		
1	P S	Right aryepiglottic fold, sinus piriformis		Teleradium 70 000 mg hr	Symptom free		Symptom free		Recurrence 1 year later	Cervical glands 6 months later	Not treated died 1 month later Thirteen months dead Three years and 6 months symptom free
2	M J	Both arytenoid regions		Teleradium 70 000 mg hr	Symptom free						Four years symptom free
3	M H	Anterior wall of hypopharynx arytenoid region		Teleradium 85 000 mg hr	Symptom free						Four months dead
4	T B	Diffuse tumor infiltration of intortus of larynx	Paralaryngeal glands of the left side	Teleradium 60 000 mg hr	Improved	Vanished	Recurrence suspected pharyngeal stenosis		Gastrostomy died 3 weeks later Tracheostomy died 1 month later		Four months dead
5	A P	Left wall of hypopharynx and intortus of larynx		Teleradium 74 000 mg hr	Symptom free		Recurrence 6 months later		Electro-endothermy died 6 months later		One year dead
6	A L	Sinus piriformis both arytenoid regions		Teleradium 74 000 mg hr	Symptom free		Recurrence 5 months later		Not treated died 2 weeks later		Five months dead
7	K S	Anterior wall of hypopharynx right arytenoid region		Teleradium 70 000 mg hr	Tumor partly remitting						
8	N O	Anterior wall of hypopharynx both aryepiglottic folds epiglottis	Paralaryngeal gland of right side	Teleradium 90 000 mg hr	Symptom free	Vanished	Recurrence 13 months later		Teleradium 70 000 mg hr cachectic		One year and 7 months dead
9	M N	Anterior wall of hypopharynx cauliflower tumor	Small bilateral glands (metastases?)	Teleradium 90 000 mg hr	Symptom free	Vanished					Two years symptom free
10	A C	Anterior wall of hypopharynx		Teleradium 48 000 mg hr	Died during treatment						Three weeks dead

(B) *Cancer of the Hypopharynx (Table II)*—Among 10 cases treated by teleradium, only three remain living (October, 1934) after $3\frac{3}{4}$, $3\frac{1}{4}$, and $1\frac{3}{4}$ years, respectively. One presented cancer of the piriform sinus and aryepiglottidean fold and two had tumors of the anterior wall of the hypopharynx, one of which at the same time invaded the arytenoid region. In Case 1 there appeared, six months after treatment, a large metastasis of the supraclavicular region which responded promptly to repeated teleradium treatments, since which time this patient has been free from all symptoms of cancer. In Cases 3 and 9 no signs of relapse have been observed, and likewise no difficulty of respiration or swallowing. The latter patient had, at the beginning of treatment, on each side of her larynx a couple of small, soft glands, which, however, afterward could not be verified as metastases.

Beside the above-named, three more patients have been rendered primarily symptom-free, viz., Cases 2, 6, and 8, although later on developing recurrence. In Cases 2 and 6 the hypopharyngeal tumor itself reappeared after one and one-half years, respectively, and in Case 8 there was a relapse of the glands of the neck

thirteen months after treatment. These metastases were treated anew with partial success, so that the patient was alive—though in a bad condition—for at least half a year afterward, while the other two died from their disease in a short time. At that time I did not take the risk of repeating the irradiation for fear of laryngeal necrosis. Nevertheless, these three cases do represent a palliative result not to be underestimated. Their tumors were localized to the arytenoid region, the piriform sinus, and the epiglottis, respectively.

Of the remaining cases, No. 4 had a large, diffusely infiltrating tumor with stenosis of the larynx, so a tracheotomy—and, later on, also a gastrostomy—had to be performed. The patient never became free from his local tumor and died four months after treatment from distant metastases. No. 5 was treated for a fairly large tumor of uncertain origin, located in the left arytenoid region. This tumor melted away promptly, but on account of respiratory troubles it proved necessary to perform a tracheotomy. The result was unsatisfactory, and this patient died from dyspnea before the reaction was at an end. Case No. 7 had a large cancer of the anterior wall of the hypopharynx, but did not become free from symptoms. Five months later a new growth reappeared which led to her death in a very short time. The last patient, Case 10, also had a large tumor of the anterior hypopharynx and died during treatment from perforation of the tracheal wall, followed by pneumonia.

Consequently, from this material of eight intrinsic laryngeal cancers and ten cancers of the hypopharynx, there remain five symptom-free of the first and three of the second group. With such small numbers, it is useless to make up a percentage computation. Somewhat more interest might be taken in a report of the clinical stages of my material at the time of treatment, presented in Table III, in which I have tried to express the stage of operability in every case by the operation required, in instances of surgical treatment.

TABLE III—CANCER OF LARYNX

Laryngofissure, extirpation	Cases 5, 6, 8, 9
Hemilaryngectomy	Cases 1, 2
Total laryngectomy	Cases 3, 4

CANCER OF HYPOPHARYNX

Laryngectomy, with resection of pharynx	All cases except 4 and 8
Inoperable	Cases 4 and 8

Here, I wish to remark that the statements regarding operability, at least as far as the hypopharynx tumors are concerned, must be given with the utmost reservation. In the majority of such cases, it may be very difficult to estimate the so-called operability, as indicated by surgical statistics in this field. Generally, these tumors are considerably more advanced than might be supposed before operation, and relapses appear more or less swiftly. This may be gathered, for example, from the monograph of Zuppinger (*Maligne Pharynx- und Larynx-tumoren*, Leipzig, 1931, p. 141). Among 120 cases of hypopharyngeal carcinoma observed, only 17 (14.2 per cent) showed an operable stage, only five were radically operated upon and all these died afterwards, three in consequence of the operation and two from recurrence of the cancer.

The deaths in my material were in most cases (three laryngeal and five hypopharyngeal cancers) caused by local recurrences or partly persisting tumors. Two patients have succumbed during or shortly after treatment from dyspnea or aspiration pneumonia. Further, in one case (No. 6) the reappearing tumor has been operated upon by electro-endothermy, but with a fatal result. Finally, in one case of hypopharyngeal cancer (No. 4), late bone metastases have been the cause of death.

Laryngeal injuries accompanied by local recurrences (and consequently not to be regarded as caused only by radiation) have been recorded in two cases, both intrinsic cancers of the larynx (Cases 3 and 4). In the first one, there had probably been already an invasion of cartilage by the tumor before treatment, in the latter, the conditions were radically affected by

a previous operation. Furthermore, as we have seen above, the local reactions of the mucous membranes have as a rule shown a relatively mild character, and such injuries as might be charged against the radium therapy *per se* have not been observed in these teleradium cases. On the other hand, I have seen an undoubted case of laryngeal necrosis, with fatal termination, in a patient who was treated in 1933 by the fractional roentgen method for a carcinoma of the hypopharynx with large glands in the neck.

The experiences from teleradium treatment in this material may be considered, according to my opinion, as on the whole encouraging. The cases have not been selected other than as patients brought to roentgen treatment, who showed large or extended metastases and on whom, on technical grounds, teleradium could not conveniently be used. With intrinsic laryngeal cancer, the results seem to compare favorably with those of surgery, as far as the primary tumor is concerned, but from the point of view of function the result is far better, at least in cases for which surgical treatment would have implied a laryngofissure. Moreover, teleradium has the great advantage also of involving a powerful treatment of the metastases, present or to be apprehended, thereby proving its superiority to other methods of radium therapy, for instance, the fenestration technic of Seifert. On the other hand, we must admit that the local and general difficulties following as consequences of teleradium treatment must not be underestimated. At best, they imply a fairly trying encumbrance of the patient during several weeks. On the contrary, with cancers of the hypopharynx

in which surgical interference, even in the most skillful hands, only exceptionally may result in real cure (generally at the cost of severe mutilations, converting the patient's life into a martyrdom), radiation therapy without question is the method to be preferred. From my experience, I believe also that teleradium, if technically applicable, is to be employed more advantageously than fractional roentgen treatment because of its causing more favorable biological effects and entailing considerably less risk as regard to both skin and mucous membrane changes. Further, the general radium symptoms likewise seem to be less trying than those of the Coutard method. Especially I wish to lay stress upon my never having observed any heart conditions, either in this material or in teleradium therapy as a whole, such as are described after heavy doses in protracted roentgen treatment.

The results reported above are, however, only primary. The future will show in what degree they represent permanent cures. Especially, the results in hypopharyngeal carcinoma are far from satisfying. Perhaps in course of time some one will succeed in finding new methods in teleradium therapy, which may improve its results. Larger quantities of radium and, in consequence, greater focal distances will undoubtedly render possible a more homogeneous depth irradiation. On the other hand, it seems necessary to try a cautiously increased dosage technic in order to obtain a really permanent cure through the first treatment. According to recent experiences, it would seem that such a practice may not involve quite the risk that one might suppose, but its results cannot yet be estimated.

FIBRIN BODIES IN ARTIFICIAL PNEUMOTHORAX¹

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FIBRIN bodies in the pleural cavity are relatively rare. Most textbooks on pathology and roentgenology make no mention of them. During the past two years we have observed fibrin bodies in 94 patients who were receiving collapse therapy by artificial pneumothorax for a malignant type of pulmonary tuberculosis (13 and 20).

Fleischner (5) first described the appearance of a fibrin body in a pneumothorax cavity in 1922; he believed that it was formed by the coalescence of fibrin particles which had separated out of a pleural effusion. Dull (3), in 1925, advanced the thought that injury to an intercostal vessel during a pneumothorax refill resulted in a hemorrhage, and that blood fibrin separated out from the blood clot to form a "blood fibrin ball." The formation of a fibrin body by the deposition of fibrin particles about a nucleus was suggested by Stoffel (19), in 1926, the nucleus being a ruptured adhesion.

Brandt (2) produced fibrin bodies in pleural cavities of dogs by injecting tar and scharlach R. He reported his experiments in 1927, and concluded that a nucleus was necessary for the formation of a fibrin body.

Heacock and Van Ness (7), in 1932, reported the appearance of a fibrin body in a case which developed a spontaneous pneumothorax. This occurred in a three-and-one-half-year-old child, ill with a streptococcal septicemia. There was no pulmonary tuberculosis. The fibrin body appeared subsequent to the development of a pleural effusion. At no time was a thoracentesis performed. The child recovered, the lung re-expanded, and the fibrin body disappeared.

Wischnowitz (21) reported a fibrin body, found on postmortem examination, to be composed entirely of fibrin.

In our series of 94 patients, a pleural effusion was present in 91; in the remaining three instances, it was not observed. Of the 91 cases with a pleural effusion, the fibrin bodies appeared subsequent to the development of the effusion in 74; the effusion and the fibrin bodies were observed simultaneously in 15. In the remaining two, the fibrin bodies preceded the pleural effusion by several months. In one of these cases there was an adhesion band extending from the lower portion of the mediastinal surface of the left lung to the pericardium. With increasing pressures (during pneumothorax refills), this band became taut and finally ruptured. Subsequently, a fibrin body developed along the left side of the cardiac shadow, at the site of the adhesion band.

Fibrin bodies usually appear in the lower portion of the pleural space. Seventy were attached to the lower lung margin, eight appeared in the lower portion of the pleural space, not in contact with the lung or diaphragm, five were in contact with the diaphragm, three were attached to the diaphragm and pericardium, and two were attached to the lung and chest wall. One case presented a fibrin body with multiple attachments to the chest wall, lung, and diaphragm, another to the pericardium, chest wall, and diaphragm, a third to the pericardium and chest wall, and a fourth with attachments to lung and diaphragm. Two bodies were found attached to the chest wall in the upper half of the pleural space.

Ninety cases presented single bodies of these, seven showed free mobility and 65 partial mobility; in 12, the fibrin bodies were firmly adherent and displayed no mobility; in six, mobility was not deter-

¹ A presentation of this subject based on 30 cases was presented before the Sea View Hospital Clinical Society on April 19, 1934. Since then 64 cases have been added to our series.

mined Four patients presented multiple fibrin bodies In three, these bodies showed partial mobility, in the fourth, the

smaller ones present, some were free and others were attached to the chest wall

These fibrin bodies cast dense shadows

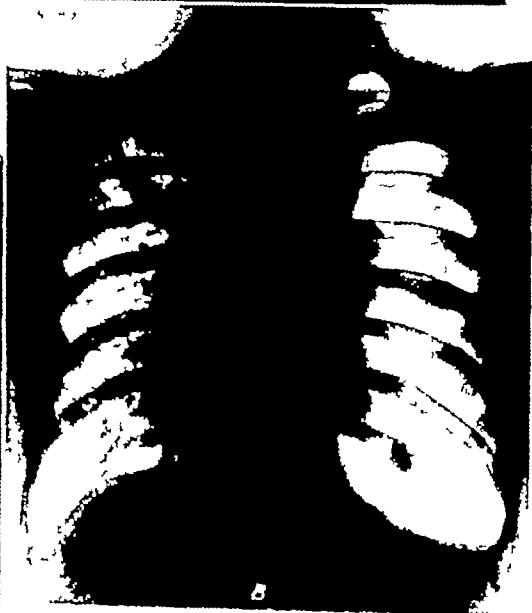
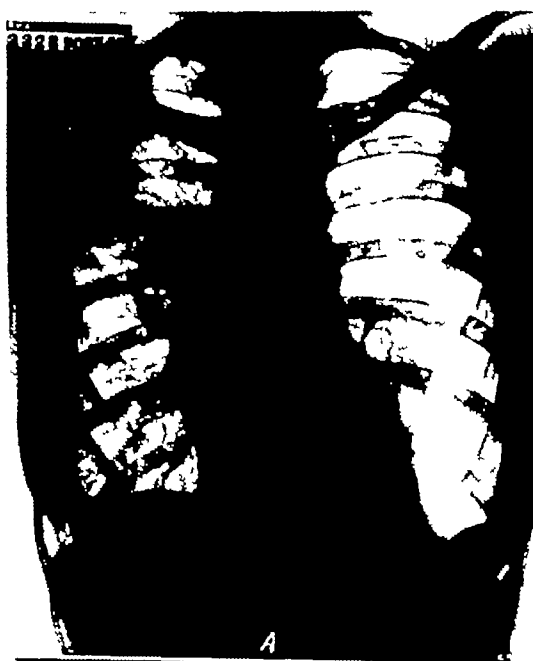


Fig 1 A B H white female aged 26 There is present a large single circular fibrin body in the left base it is freely movable Fig 1 B J O G, white male aged 46 A large single circular fibrin body is attached to the chest wall it is immobile

Fig 2 A M K white female aged 23 There is present a large oval fibrin body attached to the lower lateral margin of the right lower lobe Fig 2 B J B white male aged 26 Large circular fibrin body is attached to the lower lateral margin of the left lower lobe

largest fibrin body was attached to the lung and showed partial mobility Of the

and assume various shapes circular, oval, triangular, conical, cylindrical, elon-

gated, irregular, etc. The elongated bodies may be angulated. The majority of them have smooth outlines, irrespective of their

The fibrin bodies vary in size, in our series, the longest diameter did not exceed 8 centimeters

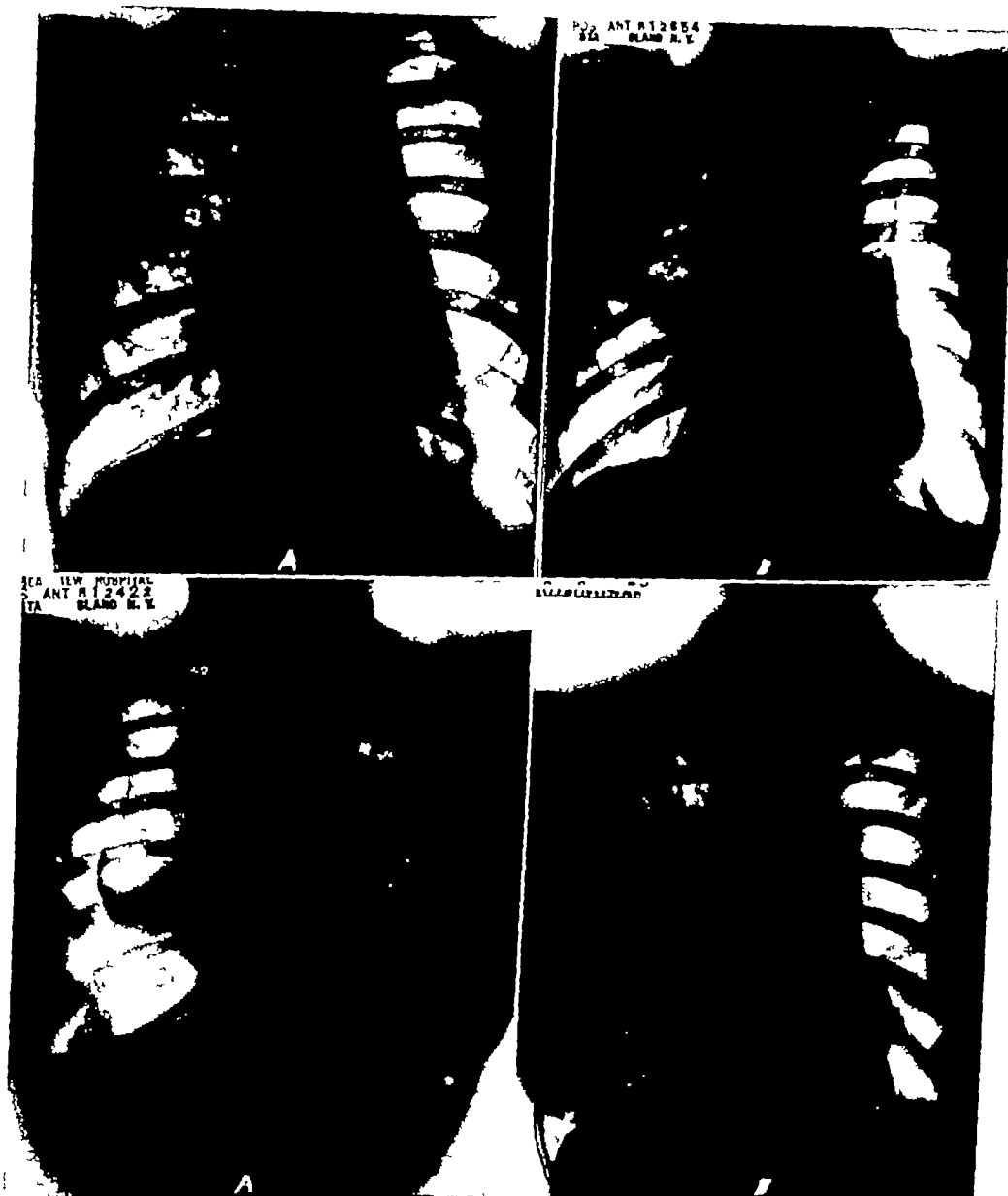


Fig 3 A P H, white male aged 18. A large oval fibrin body is attached to the lower margin of the left lung. Fig 3 B G S, white male aged 36. An elongated fibrin body is attached to the lower lateral portion of the left lower lobe.

Fig 4-A I M, white female aged 22. A large single triangular fibrin body is present in the right base, freely movable. Fig 4-B O S M, white girl aged 19. A large single irregular fibrin body is attached to lung margin, the lower third hanging free in the pleural space.

shape. Thirteen fibrin bodies showed multiple prolongations from the main mass.

Fibrin bodies, while relatively rare, are not so rare as we are led to believe, many

probably being overlooked. The large circular or oval fibrin bodies are readily recognized, particularly if they are free or at-

bodies which usually escape detection are irregular in shape, attached to the diaphragm or pericardium or the lower margin

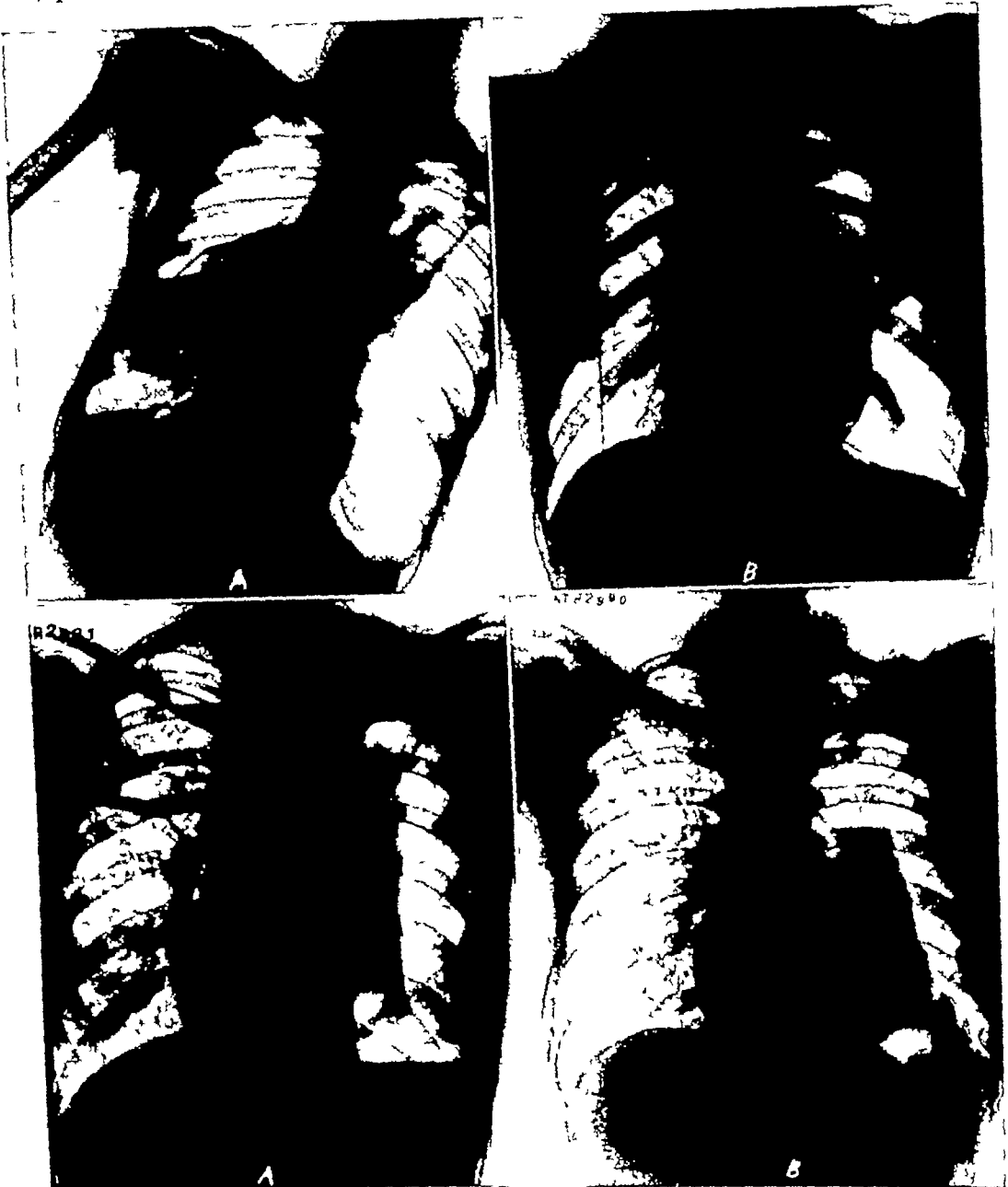


Fig 5-A J B white female, aged 25 Bilateral pneumothorax. An irregular elongated fibrin body is attached to the lung and chest wall, it is immobile. Fig 5-B J B, white male aged 23. An irregular elongated fibrin body is attached to the lung. The distal end is free in the pleural space.

Fig 6-A M B white female aged 20. A large single irregular fibrin body is attached to the lower lung margin and chest wall showing multiple prolongations from the main mass, it is immobile. Fig 6-B G M negro male aged 30. Multiple circular and oval fibrin bodies of varying sizes are found, some freely movable, some attached to lung, and others to the chest wall.

attached to the lung or chest wall, and are not of a partially collapsed lung.

shadows, or by a small effusion. It is our opinion that an active pneumothorax service should reveal annually many fibrin bodies.

The fate of the fibrin bodies is not well known. Their complete disappearance has been reported by Heacock and Van Ness. Klinkowstein and Belajewa (8) reported the disappearance of multiple bodies present in one of their two cases. In 89 of our series the fibrin bodies were still present on the last examination, two of them were lost from observation because paravertebral thoracoplasties were performed. A third disappeared when the lung had almost completely re-expanded. Originally it was attached to the lung, diaphragm, and chest wall. It retracted gradually, detached itself from the lung and diaphragm, maintaining its attachment to the chest wall on a level with the ninth interspace posteriorly, with the expansion of the lung it disappeared. The fourth fibrin body, which was attached to the chest wall on a level with the ninth rib posteriorly, gradually became smaller and smaller. A phrenicectomy was performed, whereupon the resulting elevation of the diaphragm completely overshadowed the fibrin body. The fifth case presented a freely movable fibrin body which became smaller and smaller, and which was displaced into the axillary portion of the costophrenic sinus. A pleural effusion reappeared and obscured the fibrin body.

In one of our patients (H. M.), a closed pneumolysis (Jacobæus) was performed by Dr. M. S. Lloyd, on March 3, 1934. His description (thoracoscopic) follows: "Two adhesions were severed. An irregular grayish-white, glistening, single fibrin body was observed, attached by a broad base to the lower lateral margin of the right lower lobe, tapering to the axillary chest wall. It was Y-shaped, with a thin free prolongation projecting downward, almost touching the diaphragm. The fibrin body was not firm. Portions of it were easily removed with a biopsy punch. Its attachment to the lung was loose, it being almost completely detached during manipulation.

The attachment to the chest wall was firmer. The entire fibrin body was removed except for small portions at its attachments."

In another case (G. M.), a closed pneumolysis was performed by Dr. P. N. Coryllos, on April 3, 1934. His description follows:

"Through the thoracoscope, a great number of fibrin bodies were present in the pleural cavity. A moderate amount of fluid was also present. Six of these bodies were attached to the lung, three others were fixed to the chest wall, and three were free in the pleural space. Their size varied from a cherry to a walnut. Their shape was spherical, elongated, bottle-like, dumb-bell-shape or like Indian clubs. Their color was an opalescent whitish-gray. They were soft, breaking easily. They adhered only slightly to the pleura and to the lung. They could be easily detached, leaving underneath a raw surface, occasionally bleeding slightly. The whitish-gray color sharply differentiated them from the lung or the pleura in contradistinction to pleuropulmonary adhesions which cannot be differentiated from the pulmonary parenchyma at their point of attachment. These fibrin bodies cannot be confused with the lung or the pleura. Nine bodies were then extracted."

Dr. Louis R. Davidson removed fibrin bodies while performing thoracoscopic examinations in two cases, of which his descriptions follow:

Case 1 (Feb. 1, 1935, J. H.) "The entire visceral and parietal pleurae were covered with a fibrinous and red granulating exudate. The portion of lung containing a large cavity was adherent to the posterior chest wall, and what appeared to be a band in the x-ray film was an extension of lung tissue attached to the postero-lateral chest wall. A small grayish fibrin body was located, attached to the parietal pleura. It was detached and removed without difficulty."

Case 2 (Feb. 15, 1935, A. M.) "Both the visceral pleura and the parietal pleura were chronically inflamed, studded

in areas by tubercles. A grayish plastic exudate, which was generalized, was noted to be covered in places with substantial fibrinous plaques and 'stalactites'. Seven cord-like adhesions were noted, were 'knotted' by deposition of the exudate and fibrinous deposit. A small fibrin body was located and removed."

Dr Samuel A. Thompson described the appearance of a fibrin body while performing a thorascopic examination, on May 6, 1935. His description follows:

"Patient, B. M., aged 21, showed a small fibrin body in the left pleural space attached to the lateral surface of the lower lobe and to the parietal pleura of the thoracic wall. This fibrin body, oblong in shape, about 2×0.5 cm., was a pale yellowish-gray in color, very soft, and easily displaced from the lung and chest wall with the thoracoscope. No attempt was made to remove it."

The literature records no instances in which fibrin bodies were removed from the living for study.

The pathologic reports by Dr. Oscar Auerbach (pathologist, Sea View Hospital) follow:

"Case 1. H. M., Nos. 1153 and 1154. Examination of the fibrin bodies submitted reveals, with hematoxylin-eosin stain, a dense homogeneous pink staining mass, centrally situated. At the periphery of this pink homogeneous mass are a number of intact cells, lymphocytes, polymorphonuclears, blood platelets, fibroblasts, histiocytes, and the outline of numerous necrotic cells. The central mass shows, on high power examination, numerous dense strands of fibrin beyond which are dense collections of necrotic cells. The fibrin bands at the periphery, although present, are thinner and widely separated by the intact and the necrotic cells. Fibrin stain of the same tissue reveals that the central dense mass is composed of dense bands of fibrin. Much of this fibrin is concentrically arranged, and between the dense layers of the fibrin are homogeneous areas of necrotic tissue. At the periphery of this area, the fibrin is concentrically arranged

and is present in thin strands, and between the thin strands is necrotic material. Intact nuclei as well as necrotic nuclei are also seen at the periphery of this area.

"Case 2. G. M., No. 1200. Hematoxylin-eosin stain of the tissue submitted reveals numerous individual masses, the central portions of which reveal, with a low powered examination, extensive pink homogeneous areas in which an occasional intact nucleus may be seen toward its periphery, and at the periphery of these areas a thin zone of intact cell. High power examination reveals dense layers of fibrin in the central portion, with occasional intact polymorphonuclears and lymphocytes, also numerous densely arranged necrotic cells, which appear to be enmeshed by the fibrin. The thin layer of cells surrounding the entire area is composed chiefly of fibroblasts and histiocytes. Occasional fibroblasts and histiocytes are present somewhat deeper in the pink homogeneous area. Fibrin stain of this tissue reveals dense arrangement of the fibrin, which extends almost to the periphery of the tissue. Between the dense layers of fibrin are areas of necrotic cells. At the periphery, the fibrin is loosely arranged and the areas of necrosis are greater.

"Ziehl-Neelson stain of the three tissues submitted revealed no evidence of acid-fast bacilli.

"Case 3. J. H., No. 1615. The findings were essentially the same as in Case 4.

"Case 4. A. M., No. 1640. Gross examination reveals a small white mass. Microscopic examination reveals a dense pink homogeneous mass. Toward one end of the pink mass there is a dense cellular infiltration composed of lymphocytes, fibroblasts and red blood cells, occasional polymorphonuclears, and large irregular cells, the cytoplasm of which has a web-like arrangement. The nucleus is small, oval, and vesicular. Throughout the dense pink homogeneous mass, very occasional lymphocytes and polymorphonuclears and red cells are present. Fibrin stain of the same tissue reveals a minimal amount of fibrin and it is present in the

shadows, or by a small effusion. It is our opinion that an active pneumothorax service should reveal annually many fibrin bodies.

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The cells enmeshed between the fibrin at the periphery of the fibrin body apparently are derived from blood. The presence of the fibroblasts and histiocytes at the periphery of the fibrin body is explained by an attempt at organization of the mass. It may also be concluded that the fibrin body arises from the blood elements."

Portions of the fibrin bodies removed from Case 2, G. M., were also submitted for examination to Dr. Mendel Jacob (Medical Examiner, Richmond County). His description follows:

"Gross Description"—Received four specimens, the largest roughly conical in outline, 2.4 cm. in diameter and 0.8 cm. in height. Its base and one side are smooth, somewhat glistening and membranous in appearance, finely honeycombed, and very slightly indented by numerous closely set parallel shallow furrows. The smooth surface shells easily in a layer 0.1 cm. in thickness from the underlying tissue, carrying with it few of the rougher fibers from the latter.

"The subsurface tissue is firm, approaching rubbery in consistency, of a distinctly honeycombed appearance, and separates naturally into two distinct halves along its transverse diameter. The whole specimen then gives the picture of three layers.

"The remaining specimens are of similar tissue, two being 1.4 cm. in diameter, one elongated, thin, more fibrillar in type and curling up concentrically. All show distinct layers, these tending to separate from one another spontaneously.

"Microscopic Description"—The smooth surface (see gross description) consists of compressed strands of fibrin infiltrated with moderate numbers of large and small mononuclear and scattered polymorphonuclear leukocytes and an occasional eosinophile, the majority being well preserved. Some of the mononuclear cells are elongated, tending toward the fibroblastic type, though no definite cellular fibrils are recognizable. Others are roughly polygonal, showing eccentric nucleus somewhat indented centrally, the nucleus rather coarsely chromatic, the cytoplasm pale and granular.

These cells occur in groups and in surface linear arrangement, in places resembling a lining layer, there is, however, no underlying elastic tissue (Weigert stain) or collagen fibers (Van Gieson stain) to suggest a supporting pleural structure. The surface fibrin stains more deeply with eosin than does the deeper, more homogeneous and hyaline-like fibrin. Groups of swollen, pale-staining cells give the impression that they are hulks of erythrocytes. Only occasional leukocytes remain intact, these occurring in rows lining small clefts in the fibrinous mass. All others have undergone rhexis (hematoxylin-eosin stain).

"Van Gieson stain"—Shows a homogeneous yellow stain in which outlines of red cells are visible.

"Weigert's stain"—Masses of fibrin, staining a deep blue, arranged as interlacing groups of fine fibrils. The heaviest masses taking the deepest stain are just beneath the smooth surfaces, gradually fading in amount and intensity of stain in the deeper portions.

"Elastic tissue stain (Weigert)"—Shows no elastic tissue.

"Unna's differential mast-plasma cell stain"—Shows the large swollen surface cells and cell groups described above (see general description) to have a deep blue nucleus and paler blue cytoplasm. These cells are plasma cells. No Russell bodies are apparent.

"Mallory's aniline blue stain"—Shows a coarsely reticulated framework of deep red, fibrillar material punctuated irregularly by more homogeneous patches of deep blue stained material, chiefly centrally and by yellow patches peripherally. In these yellow patches vague outlines of large, roughly round, anuclear cells can be made out with very fine reddish-orange strands in places between these cells and around the masses, in the latter location these strands become coarser, shade into a deeper red, and merge with the basic deep red reticulated background. Near the blue zones the red reticulated tissue assumes a reddish-purple and purple-blue color as one nears the frankly blue patches, meanwhile the fibers

areas in which the cells are absent. In one place the fibrin is concentrically arranged

sections studied that these masses are fibrin bodies, each presenting a central nucleus of

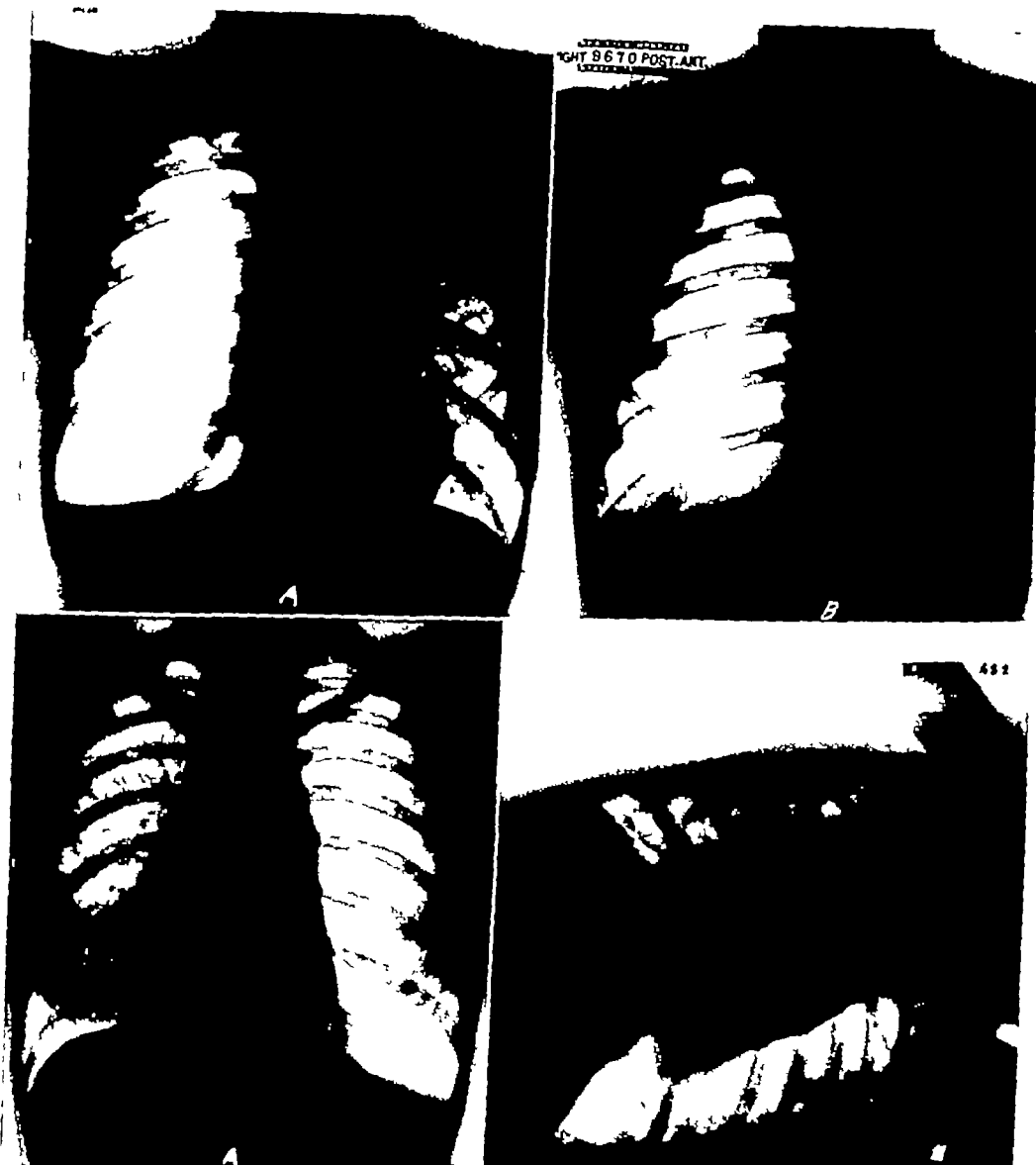


Fig 7-A S H white male aged 40. An elongated fibrin body is attached to the lung (May 11 1933).
Fig 7 B Four months later (Sept 8 1933) the fibrin body was spontaneously detached from the lung and is now freely movable. (Later examinations showed the fibrin body re attached to the lung, it subsequently detached itself a second time.)

Fig 8-A M C. negro female aged 23. A large oval fibrin body is attached to the lower margin of the lung. It is partially mobile. Fig 8 B (Examination in the lateral recumbent position right side up). The shape of the fibrin body has changed—it is now elongated and the distal end of the fibrin is free in the pleural space.

"Ziehl-Neelson stain of this tissue reveals no acid-fast bacilli.

"Conclusions—It is apparent from the

dense compact fibrin and arranged in concentric layers. Where the fibrin is most dense there is an absence of intact cells

In the case described by Heacock and Van Ness, it is possible that a hemorrhage attended the spontaneous pneumothorax. In that event the source of fibrin was either from the hemorrhage or the effusion or both.

The presence of a pleural effusion in 91 of our 94 cases would tend to confirm Fleischner's idea fibrin bodies formed by fibrin particles separating out from the pleural effusion, forming a small nidus, which acts as a nucleus for the continued deposit of fibrin, with the subsequent formation of a mass.

In prolonged pneumothoraces a fibrinous deposit is found on the parietal pleura. This deposit may become unusually thick. It may also supply nuclei for and contribute to the development of these fibrin bodies.

Fibrin bodies are associated with a pleural effusion in a high percentage of cases (96.8 per cent).

There are many patients with hydro-pneumothoraces and relatively few fibrin bodies are found. An effusion may conceal a fibrin body. It may be necessary to shift the patient into various positions to uncover a fibrin body. The presence of an effusion alone is probably not the only factor in the production of a fibrin body; there must be some other factor which causes the separation or precipitation of the fibrin. It may depend upon the presence of hemorrhage as well as on the character of the effusion. A fluid of low specific gravity, with few or no cellular elements, will probably not contribute to or be instrumental in the formation of a fibrin body.

In one of our cases the fibrin body developed, without any evidences of a pleural effusion, at the site of a ruptured adhesion, the formation suggested by Stoffel. The rupturing of the adhesion may have resulted in localized edema or a serous transudate which may have been the source of the fibrin for the formation of the mass. There may have been a blood vessel in the adhesion, in that event, a hemorrhage following the rupture of an adhesion band would be the source of the fibrin for the formation of the "blood fibrin ball," as suggested by Dull.

In our opinion the theories suggested by Fleischner, Dull, and Stoffel are potentially correct. Two of the three theories, or possibly all three, are operating simultaneously in the formation of these fibrin bodies.

SUMMARY AND CONCLUSIONS

Ninety-four cases of pulmonary tuberculosis receiving collapse therapy by artificial pneumothorax presented one or more fibrin bodies. This series includes 48 males and 46 females. Of these, 76 were white and 18 colored. These bodies were found on the right side in 39 and on the left side in 55.

Fibrin bodies are commonly associated with a pleural effusion, being present in 91 of our cases (96.8 per cent).

Single bodies were found in 90, and multiple fibrin bodies in four cases.

Fibrin bodies vary in size and shape. They are usually found in the basal portion of the pleural cavity and present varying degrees of mobility.

Thoroscopic findings are presented in five cases.

Pathologic findings were studied in four living cases; detailed findings are reported in three.

These bodies develop from fibrin derived from (1) blood, (2) pleural effusion, (3) or both.

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Figs 9 A, 9 B, and 9 C Portions of fibrin bodies removed during thoracoscopic examinations Figs 9 A and 9 B (enlarged), specimens removed from Case 2 (Fig 8 B)

becoming more or less progressively broader, losing the meshwork appearance, and merging into homogeneous acellular masses "

(The red stained substance is fibrin, the blue hyalinized substance, fibrin, the yellow, red blood corpuscles)

"*Impression*—These sections, together with the gross appearance of layering, suggest a repeated series of hemorrhages, each probably of small amount and duration As one clot formed, a fresh local hemorrhagic exudate formed, the antecedent cellular content (erythrocytes) having merged with the fibrin mass which concomitantly had been undergoing a hyalinizing process There is no evidence of any fibrosis or vascular canalization The peripheral position of the nucleated cellular elements suggests that these are reactive to a comparatively recent hemorrhage, the presence of plasma cells suggests a low grade of chronicity of the inciting irritant "

Comment—It is obvious that a source of fibrin is necessary for the formation of these bodies From an analysis of our cases it seems to us that the sources of fibrin were as follows (1) blood, (2) pleural effusion, (3) a combination of both

It is conceivable that a hemorrhage into the pleural space may be the forerunner of a fibrin body, either without or preceding a pleural effusion After the withdrawal of the needle in the pneumothorax refills we frequently see blood It is possible that at such times blood also dripped into the pleural cavity Either the intercostal ves-

sel or a vessel on the inner surface of the chest wall was injured Bleeding, following injury to the chest wall vessels or a vessel in an adhesion band, may not show external evidences The question may be justly raised, why are fibrin bodies not found more often in uncomplicated cases of pneumothorax? They probably do occur, but are missed

Blood dropped into a pleural effusion *in vitro*, depending upon the quantity, will precipitate into a mass, to which adhere cells and fibrin from the fluid It is fair to assume that the same holds true *in vivo* a hemorrhage into a pleural effusion may result in the formation of a "blood fibrin ball " This may be the explanation for the formation of free fibrin bodies If hemorrhage be the only factor these fibrin bodies should present themselves more often, for most cases of pneumothorax, if not all, at one time or another show evidences of a pleural effusion These effusions may be transient and missed if the interval between examinations is too long

The partially mobile and immobile bodies probably develop at the site of local trauma to the lung or chest wall In 70 of our cases, the fibrin bodies were found attached to the dependent portion of the collapsed lung—that portion of the lung bathed in the pleural effusion practically all the time The pleural effusion may have been the source of irritation (trauma) to the lung Local trauma may also be induced by the needle during the pneumothorax refill

DAPHNIA MAGNA AS A BIOLOGICAL DOSIMETER FOR SOFT X-RAYS

By H. KERSTEN and G. G. SNIDER, Cincinnati, Ohio

From the University of Cincinnati

LIVING animals have been used to measure the potency of various substances for many years. To illustrate, one need only mention the use of rats, mice, guinea pigs, and rabbits for the purpose of standardizing drugs, testing the efficiency of sera, hormones, vitamins, etc. In radiology, likewise, various living animals, eggs, and biological reactions of several sorts have been employed for estimating x-ray dosages. Of these, the chief ones are

such animals may be used as a dosimeter. They are easily cultured in large numbers throughout the year and have a special advantage in that one may determine by observing their hearts under the microscope, whether the animals have or have not been killed by the radiation. Those whose hearts have ceased to beat are dead, so that the result of the irradiation may be determined at once, without subsequent culturing. This paper describes experiments

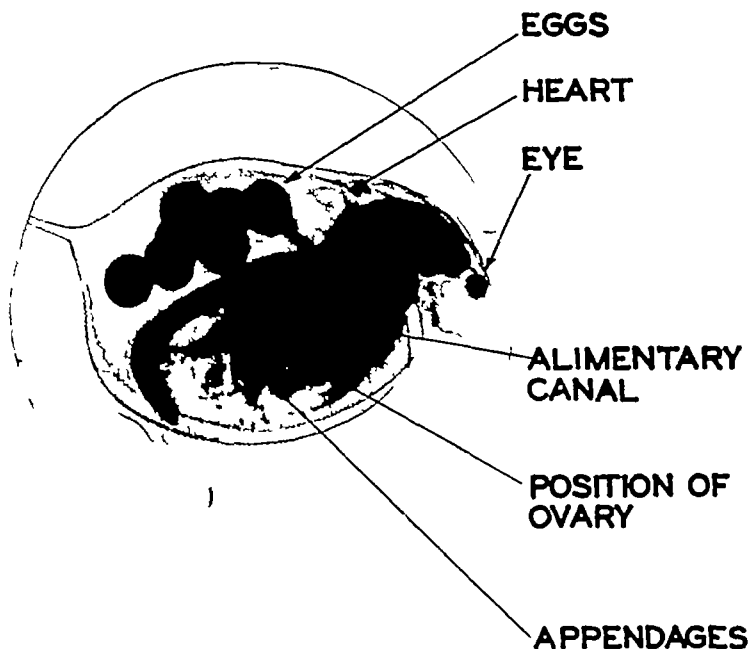


Fig 1 Photomicrograph of female *Daphnia magna* (Straus) in the first adult instar, with eggs in its brood pouch

the erythema reaction (1), the growth of seedlings (2 and 3), the hatching of *Ascaris* (4) and *Drosophila* (5 and 6) eggs, and the colony development of bacteria (7)

Daphnia may be killed by a relatively intense dose of long wave length or soft x-rays so that, if the maximum dose needed to just kill the animals be taken as a unit,

in which *Daphnia* were used to measure the dosage of soft x-rays

In the experiments, female *Daphnia magna* (Straus), raised at room temperature, and having just released their first broods, were used. Since the animals are transparent, it is possible to see many details of their internal structure without in-

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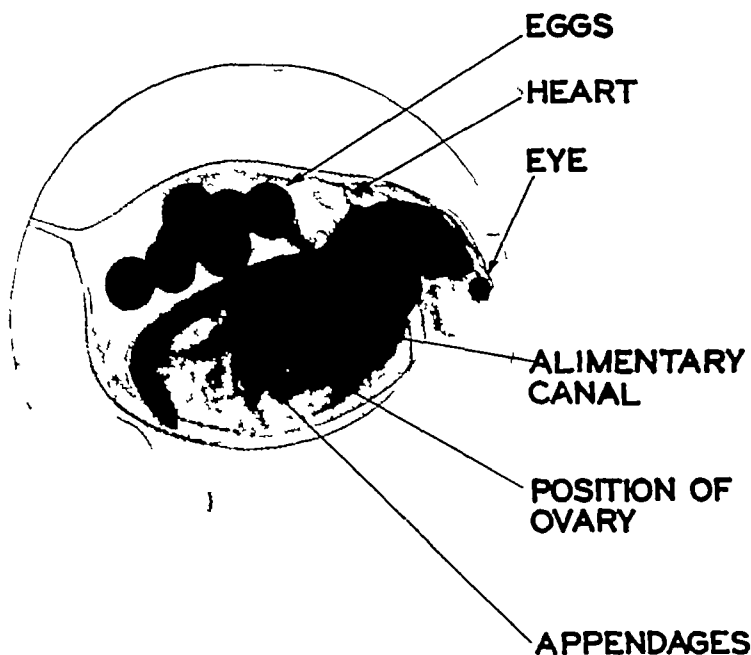


Fig 1 Photomicrograph of female *Daphnia magna* (Straus) in the first adult instar, with eggs in its brood pouch

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In the experiments, female *Daphnia magna* (Straus), raised at room temperature, and having just released their first broods, were used. Since the animals are transparent, it is possible to see many details of their internal structure without in-

uring them The general shape of the body and position of the heart and several internal organs are shown in Figure 1

Photographs taken with an oscillating crystal spectograph showed that the most intense part of the radiation transmitted

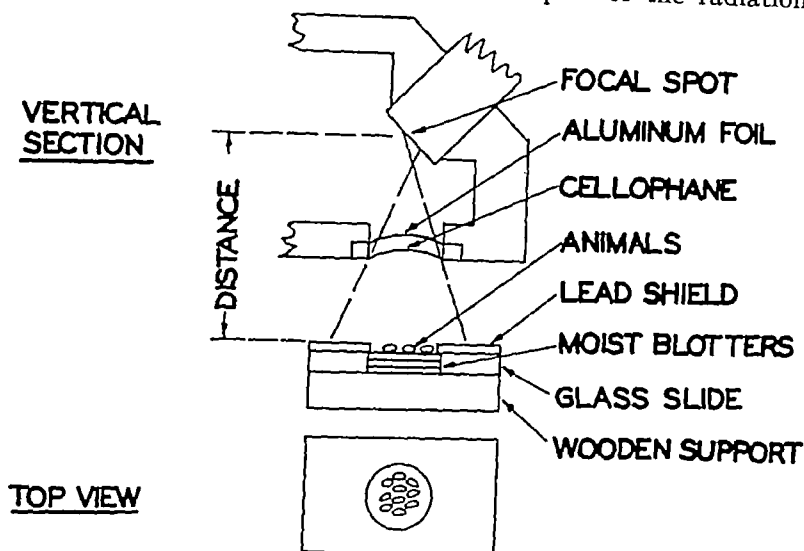


Fig 2 Drawing showing the position of the animals in relation to the focal spot of the x-ray tube

A slightly modified Banta culture medium (8) was used in rearing the animals. It was prepared by placing in a jar two pounds of garden soil and eight ounces of dried, finely divided horse manure and adding ten quarts of strained pond water. The mixture was allowed to stand for three days in a water bath at 15–20° C. It was then strained and some of the soil rubbed through the straining cloth into the medium. The young were transferred to individual bottles containing 100 c.c. of a medium made by diluting one part of the medium described above with two parts of strained pond water. After four days, about 15 c.c. of the undiluted medium was added to each bottle to provide additional food. When the animals had reached their first adult instar, with eggs in the brood pouch, they were placed in groups of ten on moist blotters in the well of a micro-culture slide, and, after irradiation, carefully removed to a glass slide, where the heart was examined microscopically.

The x-rays were supplied by a gas x-ray tube (9) having a copper target and window made of aluminum foil and cellophane, operated at 45 peak K.V. and 10 ma

by the window was the K_{α} (1.54 Å) and the K_{β} (1.38 Å) lines of the copper x-ray spectrum. The position of the animals in relation to the focal spot of the x-ray tube is shown in Figure 2.

In order to determine whether animals raised at different times under the same conditions are affected in a consistent manner by the x-rays, the curve shown in Figure 3 was prepared. The animals used for this curve were reared so as to be ready for irradiation on the five different days given by the legend in the figure. The results plotted in Figure 3 indicate that animals reared at different times are sufficiently consistent to be used as a dosimeter, if the dose is defined as the maximum needed to just kill the animals. Since gas x-ray tubes are much more difficult to operate at a constant output than filament tubes, it is possible that part of the inconsistency evident in Figure 3 is due to the variation in intensity of the x-rays and that the animals are more uniform than the figure indicates.

In order to make use of this kind of biological dosimeter, the variation of intensity of the x-ray tube with the distance

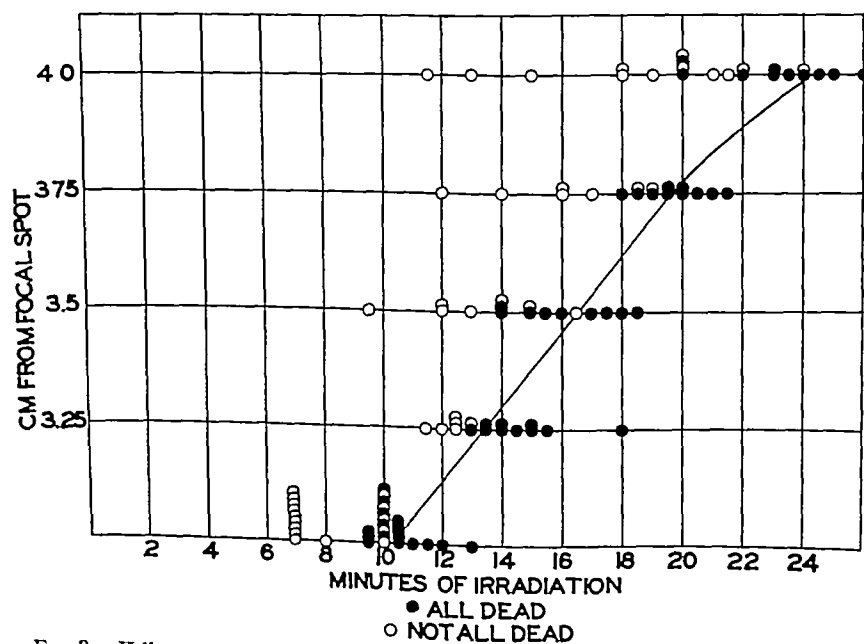
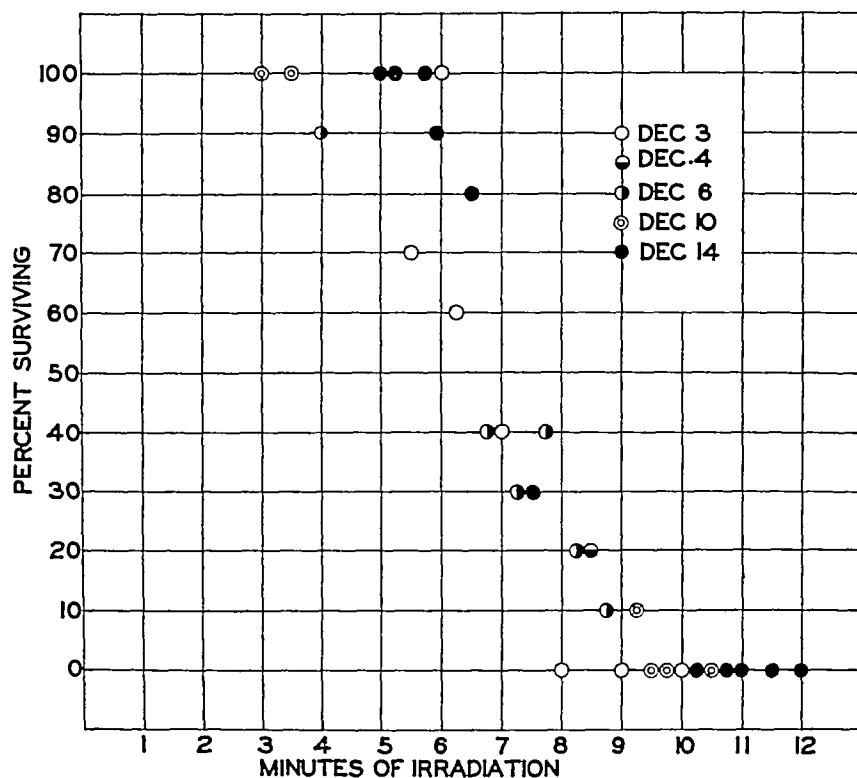


Fig 3 Killing curve for *Daphnia magna* (10) The animals were placed at 3 cm from the focal spot The x ray tube was operated at 45 peak K V and 10 ma For each point on the graph, ten animals were irradiated and the percentage surviving computed and plotted

Fig 4 Variation of intensity as a function of distance as determined by the killing of *Daphnia magna* The x ray tube was operated at 45 peak K V and 10 ma For each point on the graph, ten animals were used

from the focal spot was determined for several distances by repeating the experiment just mentioned. The results are plotted in Figure 4, in which each point again represents the results obtained by irradiating ten animals. The filled circles represent cases in which all the ten animals were killed and the open circles cases in which the ten animals were not all killed. The maximum dose necessary to just kill the animals, as a function of the distance from the focal spot, is then represented by a graph connecting the left edge of each row of filled circles.

In conclusion, it may be stated from the preceding experiments that *Daphnia magna* may be satisfactorily used as a dosimeter for soft x-rays and that for this purpose they have a special advantage in that

the dose may be determined immediately after the irradiation by a microscopic examination of the hearts of the irradiated animals.

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HYPERTROPHIC OSTEO-ARTHROPATHY

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HYPERTROPHIC osteo-arthropathy is well defined by Carr, as quoted by Stewart (11) "A disease of secondary nature occurring in the course of various chronic conditions, characterized clinically by enlargement of the extremities, with clubbing of the fingers, and thickening at the joints, or about them, and anatomically, by thickening of the soft part, especially of the distal phalanges and proliferative processes of the periosteum, particularly at the lower ends of the bones." Hypertrophic osteo-arthropathy is found as a secondary manifestation of chronic disease of the heart and lungs, particularly of the latter

The disease was first recognized by Marie, in 1890, although Bamberger had previously mentioned the condition in 1899 (8). Marie (11) believed the periosteal changes which occur to be due to absorbed toxins as the result of improper aeration. Bamberger (11) thought that a passive congestion was the basic factor in the production of the periostitis. Brooks (1) suggested that the changes in the bones were due to the effects of circulating toxins, chiefly of infectious origin, causing changes in the pituitary gland. He based his theory on the somewhat analogous lesions seen in acromegalia. There is no pathologic basis for this latter theory, since no changes have ever been found in the pituitary gland. The most recent theory is that there is a liberation of nitrogen gas in the bony structures, with an elevation of the periosteum (12).

The most important causative factors, in order of importance, are bronchiectasis, pulmonary tuberculosis with cavitation, lung abscess, chronic empyema, and congenital heart disease (7, 9, and 11). Biliary cirrhosis, chronic jaundice, common duct obstruction, carcinoma of the head of the pancreas, and benign stenosis of the com-

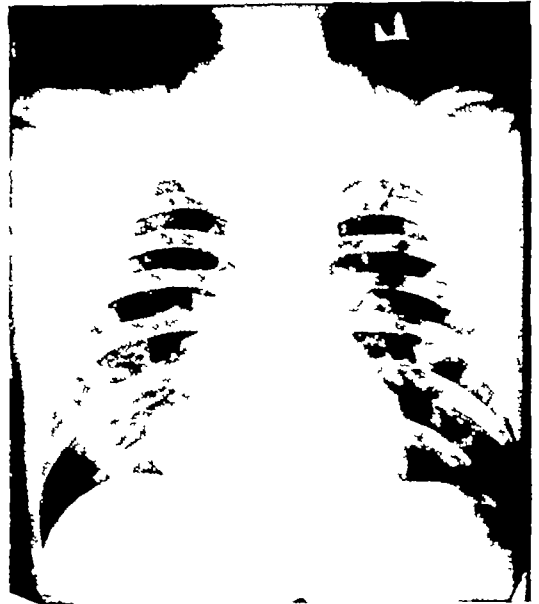


Fig 1 Case 1 Postero anterior view of the chest, showing large metastasis in right lung field close to the cardiac shadow

mon duct have occasionally been noted as causative factors (1). In addition, chronic suppurative processes in the abdomen, chronic infections of the kidney, chronic liver abscess, and long-standing dysentery are mentioned as rare causes (9).

The condition is secondary, although there are five cases in the literature without lung changes (8). These cases were reported upon about 1900, at a time when roentgenograms were not commonly utilized, no postmortems were obtainable. Five cases are also mentioned in which cirrhosis of the liver caused hypertrophic osteo-arthropathy (4), two of these cases merely had clubbing of the fingers.

It is interesting to note that in most of the cases reported the pulmonary lesion developed in comparative youth at a time when the tissues, particularly those of mesodermal origin, are easily capable of hyperplastic evolution.

The disease occurs principally in males between the ages of 20 and 40, although out of a total of 144 cases reported in the litera-

Pathologically, the condition is a slowly progressive ossifying periostitis, beginning usually in the distal ends of the diaphyses,

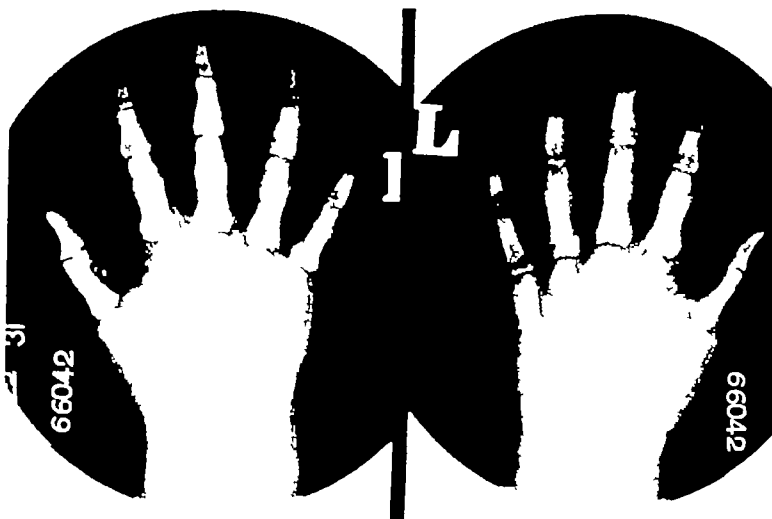


Fig 2 Case 1 Postero-anterior view of both hands showing marked proliferation which was also present in metatarsals forearms and tibiae

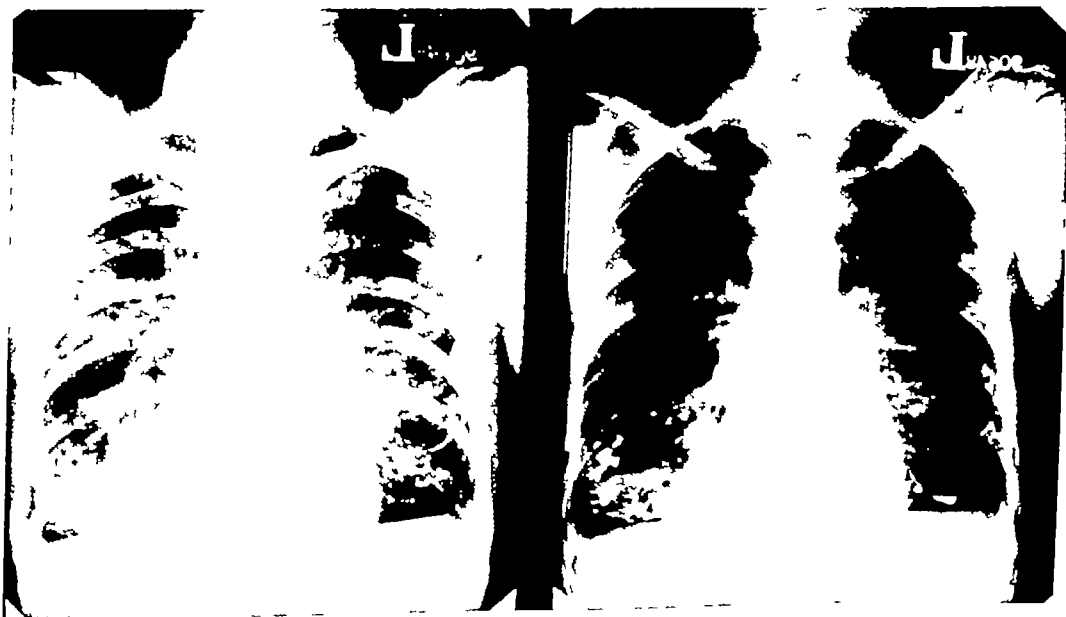


Fig 3 Case 2 A (left) Postero anterior view of chest showing moderate inflammatory changes in both lower lung fields particularly the right

B (right) Postero-anterior view of the chest after the instillation of lipiodol in the trachea showing saccular bronchiectasis in the right lower lung field

ture up to 1916, seven had occurred in children (6), the youngest of whom was 28 months (5) The condition has been found to occur in animals (12)

occurring first in the bones of the forearm and lower legs, later involving also the other bones of the limbs, and even in some cases nearly all the remaining bones of the

skeleton Concomitant with the periosteal proliferation there is also a rarefying osteitis of the shaft, with fatty changes of the marrow There may be also thickening of the peri-articular tissues of the joints, frequently with effusion Sometimes erosions of the joint cartilages occur The bulbous swelling of the fingers and toes was first described by Hippocrates (8 and 11) Brooks (1) has well pointed out that clubbing of the fingers and toes is really the first stage of this condition Distinct thickening of the subcutaneous tissue in the malar regions is also noted Bone changes may often be found in the patients who present clubbing of the fingers, as Locke (8) found 12 out of 39 patients with definite bone changes, yet there were no other symptoms except clubbing of the fingers These 12 had pulmonary tuberculosis, bronchiectasis, asthma, cirrhosis of the liver, and cardiac changes Kessel (7) found 27 cases out of 100 with marked pulmonary tuberculosis, and believes that the condition is more frequent in pulmonary tuberculosis than the usual clinical examination would warrant one in believing

COURSE OF THE DISEASE

The changes in the periosteum will often disappear as the primary lung condition improves Phemister (10) and Butler (2) cite cases of lung abscesses in which the bone changes disappeared as the pulmonary lesions healed The converse is sometimes true, although not often If the lung condition is due to either primary or secondary neoplastic involvement, irradiation therapy to the lung-fields may cause regression of the periosteal bone changes Paterson (9) cites such a case in which the mediastinum was involved by what apparently was some type of lymphoma, since the condition grew better in a short time under irradiation therapy We have not had an opportunity to treat our case which had a malignancy None of our patients improved

Case 1 G H, male, white, aged 37 years, hospital No F8868, was admitted on Oct 19, 1931 The patient complained



Fig 4 Case 2 Anteroposterior view of right ankle and knee showing periosteal proliferation along the lower medial portion of the fibula and the corresponding portion of the tibia Remainder of skeletal system showed no changes

of swelling and pains in the joints, enlargement of the nose, and loss of weight In July, 1929, a mass had been removed from the left groin In September, 1929, and February, 1930, recurrences had been removed The pathologic diagnosis was fibrosarcoma Eight months before entrance to the hospital, he began to have enlargement and pain in the ankles Successively, his knees, wrists, and hands have become involved, and his nose has enlarged He has lost 80 pounds within the last year His family and past histories are unessential Examination revealed his nose to be definitely enlarged His hands, feet, wrists, and ankles are very large His fingers and toes are clubbed The knee joints are enlarged and tender There is pitting edema on the dorsum of the feet The tibiae and radii are definitely thickened The heart is

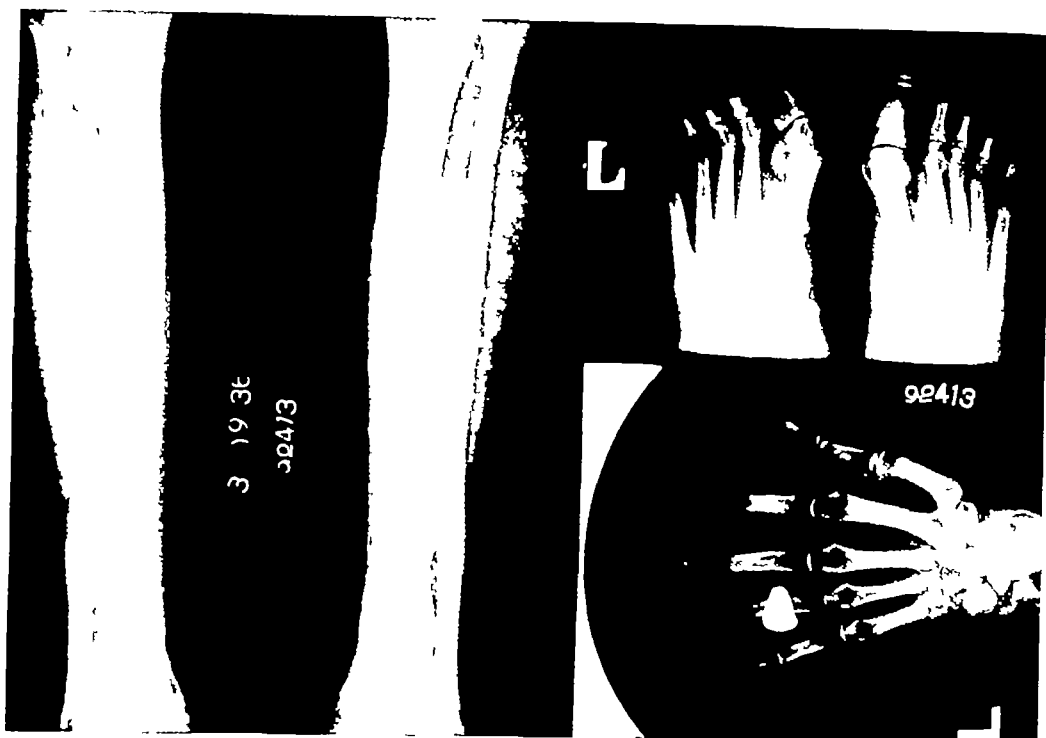


Fig 5 Case 3 Anteroposterior views of feet, left hand, and both tibiae showing periosteal proliferation of all the bones

enlarged. The liver and spleen are not palpable.

Laboratory data—Skull and sella, negative by roentgen ray. Hemoglobin, 75 per cent, red blood cells, 4,500,000, white blood cells, 93,000, polymorphonuclear lymphocytes, 52 per cent, uric acid, 3.5 per cent, urea nitrogen, 14 per cent, creatinine, 1 per cent, pH, 3.5 per cent, Ca, 9.5 per cent. Wassermann and Kahn tests were negative. Urine was negative. Electrocardiogram was negative. The patient did not improve, and died at home in June, 1933.

Comment—Case 1 represents the type in which metastatic malignancy of the lung (Fig 1) resulted in marked periosteal changes of the skeletal system (Fig 2). In spite of the marked periosteal changes which involved all the long bones and hands and feet, the calcium metabolism was normal, as the blood calcium and phosphorus were within normal range.

Case 2, M. E., male, white, aged 30 years, hospital No. K7730, was admitted to

the University Hospital, Dec. 21, 1934. The patient complained of cough, with expectoration of foul sputum, shortness of breath following exertion, nasal discharge, swelling of ankles, knees, and hands, and weight loss. In 1927, at the age of 23, he began having cough with a small amount of sputum. A nasal discharge was also noted. Cough and sputum have grown progressively worse. In 1929, his tonsils were removed without relief of symptoms. In May, 1933, he coughed up one-half cupful of blood. In 1932, he first noticed shortness of breath on exertion, with swelling of knees, ankles, and hands. He has lost 20 pounds in the last two years. He himself noticed clubbing of his fingers in 1930. His family and past histories were unessential. Examination revealed bilateral exophthalmos. His nose was not enlarged. He had considerable anterior nasal discharge. There were moist râles at both bases. There was clubbing of all the fingers and toes. Forearms and tibia were not prominent.

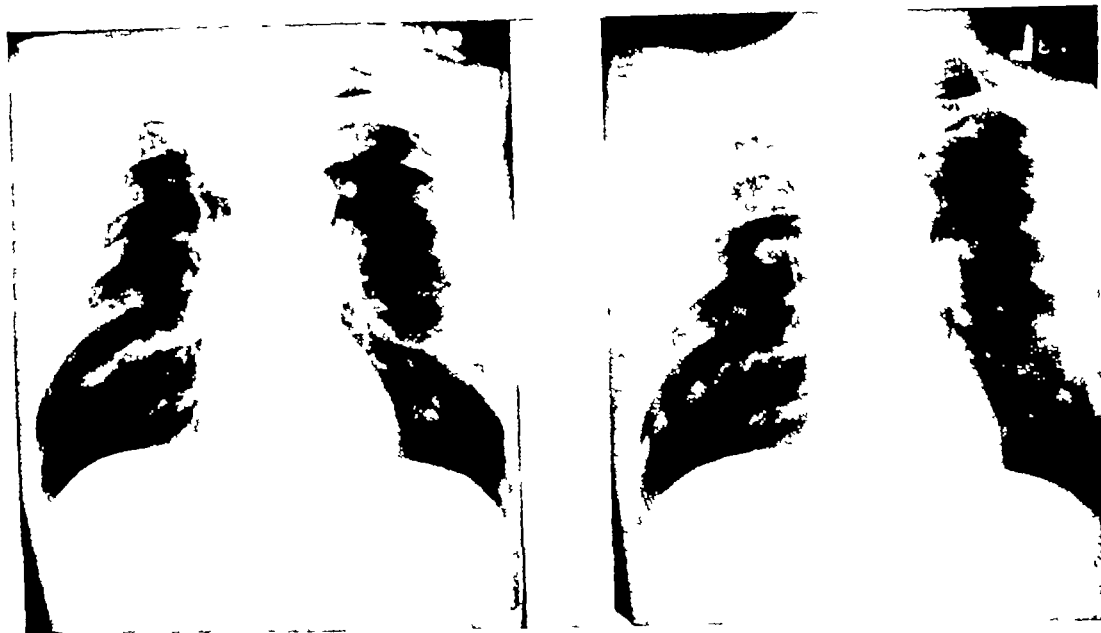


Fig 6 Case 3 A (left) Postero anterior roentgenogram of chest on patient's entrance, showing increased density of the right apex. No ribs were involved.

B (right) Postero-anterior roentgenogram of chest three weeks later. The patient now has a dry cough. The process in the right apex to the upper lobe has increased. Ribs are not involved. There is no pain in the neck or arm, there are no pupillary changes.

Laboratory Data—Hemoglobin, 80 per cent, red blood cells, 5,020,000, white blood cells, 8,800, polymorphonuclear leukocytes, 68 per cent. Wassermann test was negative. Blood chemistry was not done. Urine was negative. The patient's condition has remained stationary.

Comment—Case 2 represents the common etiologic factor in the production of hypertrophic osteo-arthropathy, namely, an infectious process in the lungs (Fig 3). This case also represents the early periosteal changes (Fig 4). Roentgenograms of the knee and ankle were taken because of the patient's pain, the periosteal changes were unexpected.

Case 3 J. H., male, white, aged 54 years, hospital No. K11595, was admitted to the University Hospital on March 16, 1935, because of shortness of breath and weakness of four weeks' duration. In 1922 he had gonorrhea, and six weeks later there developed a marked swelling, pain, and tenderness of both knees, hips, left ankle, and foot. He was in the University Hospital at this time and the only thing of interest was that his fingers were not clubbed.

Three months later he was perfectly well, one year later he had another attack which also disappeared within a few weeks. In November, 1934, another episode of swelling and pain in the knees and ankles occurred. The swelling and redness subsided but the pain has persisted. He has been very weak and short of breath for the last month. He has had an elevated daily temperature since November, 1934, and has lost 70 pounds. Upon close questioning he admitted a moderate dry cough for several years. Examination revealed the chest to be barrel-shaped, the vital capacity was 3,600 c.c. He had marked clubbing of the fingers and some clubbing of the toes. The remainder of the examination was negative.

Laboratory Data—Hemoglobin, 60 per cent, red blood cells, 4,080,000, white blood cells, 9,000, polymorphonuclears, 72 per cent. Wassermann test was negative. Three blood cultures were sterile. On several occasions the sputum was negative for tuberculosis. Urine was negative. The patient's temperature was rather septic, and he has been getting progres-

sively worse. The pathologic process in the right upper lobe and apex (Fig 6) has gradually spread. This was thought to be an inflammatory process because of the absence of rib involvement, the lack of pain in that side of the neck, and the failure of involvement of the cervical plexus of that side.

Comment.—Case 3, to my mind, also represents periosteal changes (Fig 5), due to a chronic inflammatory process of the lungs.

SUMMARY

(1) Hypertrophic osteo-arthritis is always secondary to a chronic condition, usually in the lung.

(2) Clubbing of the fingers is the first stage in hypertrophic osteo-arthritis, and, if the cause remains, periosteal proliferation of the long bones will eventually occur. Clubbing of the fingers will disappear if the cause is removed as in the case of the subclavian aneurysm reported by Funk (3), in which the clubbing disappeared as the size of the aneurysm diminished following ligation.

(3) When extensive periosteal prolifera-

tion is seen in the roentgenogram of an extremity, chest films should be taken in an effort to locate the primary cause.

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EVIPAL ANESTHESIA FOR RADIUM THERAPY

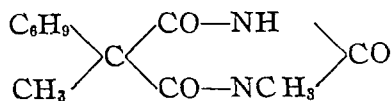
By GRAY H TWOMBLY, M D , and GEORGE T PACK, M D , the Memorial Hospital,
New York City

THE intracavitary and interstitial use of radium usually requires some form of anesthesia. Local infiltrative and conductive (nerve block) anesthesia is frequently employed for the interstitial irradiation or surgical excision of intra-oral cancers. The surgical approach for radium therapy of cancers of the uterus, rectum, and urinary bladder is often done through the medium of spinal anesthesia. Local anesthesia is not suitable for the introduction of radium needles or radon seeds into bulky tumors of the trunk and extremities, or into the breast and axilla involved by mammary cancer. The majority of these treatments (*i e*, the surgical implantation or placement of the radium) are given in less than ten minutes. It would seem that the technical difficulties, dangers, unpleasant sequelæ and relatively long periods of recuperation from general and spinal anesthesia, as well as the apprehension and nervous shock of local anesthesia, might be avoided by the employment of an anesthetic with the following properties: rapid induction, ease of administration, short period of anesthesia with immediate and complete recovery, safety, and low toxicity. These qualifications have been met by sodium evipal, the new intravenous anesthetic recently introduced into this country. It was our privilege to test its value, several months before it was placed on the American market. It seems to be ideally suited for the short anesthesia necessary in interstitial and intracavitary irradiation and on this account it is of great importance to radiologists.

PHARMACOLOGIC ACTION

Evipal is the trade name given to N-methyl cyclohexenylmethyl barbituric acid. In Europe, it is known as evipan. It is a white, tasteless, odorless crystalline com-

pound with a melting point of 143–145° C. The structural formula is



The compound itself is only slightly soluble but the sodium salt is very soluble though unstable in solution, decomposing in a few hours. It was developed in the laboratories of the I G Farbenindustrie Aktiengesellschaft, in Elberfeld, Germany, and was first described by Dr H Weese in 1932 (1), who credits the invention to Dr Ludwig Taub and Dr Walter Kropp (2), workers in the same laboratories.

Experiments on the pharmacologic action of this drug were first carried out by Weese using mice, cats, dogs, and canaries. He found these animals to act in nearly the same manner. Canaries went to sleep in 8 minutes when given 3 mg by mouth, and slept 30 minutes. Mice slept from 3 to 4 minutes after a similar dose, 120 mg per kilo, and waked in 50 to 60 minutes. The lethal dose for mice and dogs was found to be 3.3 times the effective anesthetic dose, while in cats the therapeutic index was four. (Kennedy found a therapeutic index of 4 in mice and rats. In guinea pigs, 2.5 times the therapeutic dose caused death.) In a later paper Weese reports on further pharmacological studies in cats, whose reactions to narcotics of the barbital series he says are similar to those of human patients. The animals were injected with a 10 per cent aqueous solution of sodium evipal intravenously. They went to sleep quietly in about one minute and remained so from 8 to 190 minutes, depending on the dose. The minimal dose to give complete anesthesia when given intravenously in 2 minutes was 25 mg per kilo. A dose of from 100 to 110 mg per kilo resulted in death from respiratory paralysis,

a therapeutic quotient again of about 4. In animals poisoned with phosphorus and in others in whom the liver had been removed, recovery from the effect of the drug was much slower than in normal animals, suggesting that the chemical is detoxified in the liver. It is secreted unchanged by the kidneys and can be detected in the urine, but most of it (97.2-97.7 per cent) is changed into urea by the liver. The process is rapid, rabbits decomposing half the narcotic dose in 13 minutes. The respiratory quotient and alkali reserve are unchanged (Weese), while the blood sugar level remains the same (Kennedy and Narayana).

The effect of repeated injections of the drug is not cumulative or harmful. Weese has injected cats and rabbits daily for 50 days with 80 mg subcutaneously without any evidence of toxicity or even loss of weight. At the end of this prolonged period the amount necessary to cause sleep was about 25 per cent more than at first but the effect of the drug was the same, namely, short, undisturbed sleep.

Kennedy and Narayana have also carried out extensive pharmacological studies on the drug. They find that when a frog's heart is perfused with a solution containing it, the organ is depressed and its beating may be stopped but it promptly recovers with washing, while perfusion of a second heart with the washings show the same depressing effect, that is, the drug is not fixed in any way by the heart muscle on which it acts. The ventricle seems to be slowed before the auricle.

The investigators find a 37 per cent slowing of respiration in mice, rabbits, and rats. The body temperature falls on the average 3° F in rats, 1.5° F in rabbits, and 2.5° F in guinea pigs. A slight fall in blood pressure (10-25 mm Hg) is an almost constant finding in animals.

TECHNIC AND DOSAGE

Evipal is supplied as the soluble sodium salt, which is readily dissolved in water. Ampoules containing 1 gm of the drug are dissolved in 10 c c of sterile distilled water

and this solution is injected intravenously with suitable aseptic precautions. The tendency seems to be more and more marked to give no fixed amount of the solution but to inject it rather rapidly at first 1 c c in from 10 to 15 seconds, noting accurately the amount necessary to produce sleep. A further equal dose or even double this amount can be added, depending on the depth and duration of the anesthesia required. In general, 10 c c of the 10 per cent solution is regarded as the maximum, although many leave the needle in place and give a second dose as the effect of the first begins to wear off. When administered in this manner, as much as 20 c c can be used safely. This method of calculating dosage seems to be more in favor than that recommended by manufacturers, who suggest 6 c c of the 10 per cent solution for every 100 pounds of body weight.

In the cases observed by us, we have tended to be conservative in the amounts given and for the most part have administered only enough to render the particular surgical or manipulative procedure possible. In general, we have given only 2-3 c c more of the solution than that quantity which induced sleep. The entire drug has been injected usually in from 1 to 2 minutes.

The patients fall asleep quietly for the most part. If they are counting, they suddenly begin to slow up and usually stop and fall sound asleep before they reach twenty or thirty. There are quite often some tonic or clonic contractions of the muscles but these tend to last only a minute or so. They are brought on frequently by painful stimuli, such as the introduction of a cystoscope or incision of the skin. It is necessary to see that the patient has a free air way and that his tongue does not fall back. There have been several reports (Slot and Galley) of difficulties in respiration with the onset of anesthesia but we have had none so far in our short series.

CLINICAL RESULTS

The first report of the clinical use of evipal was by Scharpff, who had used the drug

by mouth in treating insomnia. He pointed out the advantages of the shortness of the narcosis, particularly when used late at night, the patient waking normally in the morning. Ernst reported 250 cases in January, 1933, and speaks of knowing of over a thousand more without mortality. He counts as undesirable results, two cases of headache, three cases of vomiting, one case of double vision, and two of restlessness.

In Weese's second report on the pharmacology of the drug, in 1933, he says in the last paragraph that 10,000 patients have been treated under the influence of the drug without accident. One patient died suddenly for some unexplained reason after a curettage for a septic abortion while under evipal narcosis. This had been induced with 5 c c of 1 per cent solution, a light dose.

In July, 1933, the Committee on Anesthesia of the British Medical Research Council reported favorably on the value of the drug. They mention that 25,000 cases at that time had been reported in Germany, with but one death attributed to evipal.

Since its discovery, 163 articles have been published up to January, 1935, concerning its use, most of these being in German. One of the best articles in English concerning the clinical use of evipal is that of Jarman and Abel reporting the results of its use in 1,000 cases. They use 2.3 c c of a 10 per cent solution for short operations in the out-patient department, allowing the patient to go home an hour or so later. In doing major surgery, these writers use a pre-operative medication of Omnopon gr 2/3 and scopolamine gr 1/150 given one hour before the operation and repeat the full anesthetic dose of evipal as often as necessary, the maximum number of times they have done so being four in two hours. They list as contra-indications, liver damage or jaundice, low blood pressure, or previous medication with other barbiturates. They believe it should not be given to persons in the upright position, as for dental extractions. They have had no deaths from the anesthetic and no serious compli-

cations. Jarman has since given 1,400 additional anesthetics without a death.

Not nearly so favorable is the report of Slot and Galley, who record five personal cases which reacted unfavorably to the drug. The first died of bronchopneumonia five days after the anesthetic (given for the repairing of a cut throat and supplemented with ether), the second had a temporary cessation of respiration relieved by the introduction of an intratracheal tube, the third died sixteen hours after the implantation of radon in the tongue. The remaining two patients were cases of temporary respiratory paralysis. The authors also record briefly six other cases of death under evipal anesthesia. These were not seen by them and are not fully recorded. It hardly seems fair from their account to attribute these fatalities to the anesthetic.

A much more convincing account of a severe complication following the use of the drug is that, by Landau and Wooley, of a normal young man of 23 who received 10 c c of a 10 per cent evipal solution for the excision of a wen of the scrotum. Recovery was accompanied by restlessness and headache for two days. On the third day he had severe frontal headache, photophobia, nystagmus, and a pulse rate of 40. On the fourth day his pulse was 36 and he was drowsy, blood pressure 135/80, all reflexes were exaggerated. A lumbar puncture was negative save for an initial pressure of 170 centimeters. In other words, he had the signs and symptoms of cerebral edema which lasted for eight days. His recovery was uneventful and there were no sequelae.

Anschutz, in a complete and convincing paper delivered before the Deutsche Gesellschaft für Chirurgie in April, 1933, records the results in a series of 6,400 cases which were carefully controlled. Of these, four died. The fatalities occurred in old, debilitated persons and Anschutz believes that all received too large a dose. He mentions four other cases, gathered singly from the literature without any figures as to the number of successful cases in the same series.

The drug has been introduced only recently in this hemisphere. Gavin Miller records 22 cases from Canada, with good results in 20. In one case, no anesthesia was obtained. One child of 13 had convulsions following the injection of the drug. Another report from Canada by Heard is of 30 cases without complication. In this country the most extensive report is of 280 cases without mortality by Livingston, Emy, and Lieber, from Bellevue Hospital. Brugess used it for minor genito-urinary surgery on 25 patients with good results and no complications.

USE IN RADIUM THERAPY

The cancer surgeon has numerous opportunities for a short, safe anesthetic such as evipal, *e g*, simple vulvectomy, penectomy, orchidectomy, cauterization of the cervix or trachelectomy, cystoscopy for diagnosis, biopsy or fulguration of papillomas of bladder, diagnostic curettage of uterus, minor amputations, simple or palliative mastectomy, colostomy, antrotomy, resection of mandible, enucleation of eye, cautery excision of tongue, endotherm excision of laryngeal papillomas, excision of soft-part tumors, curettage of giant-cell tumor of bone, and occasional formal biopsies.

It is in the interstitial and intracavitary placement of radium that the advantages of evipal are most apparent, because these procedures are usually done so quickly that inhalation and spinal anesthetics, with their attendant dangers, discomforts, and duration, are hardly justifiable. There is no stage of intoxication with evipal anesthesia, the induction and recovery are quiet, swift, and comfortable. Many patients are ambulatory shortly after consciousness is restored. We do not necessarily recommend the routine substitution of sodium evipal for local or other forms of anesthesia, but we do assert that its worth has been amply demonstrated to us in many instances.

The surface application of radium is a painless procedure, but the interstitial and intracavitary placement of radium re-

quire a surgical approach, therefore, some form of anesthesia is usually indicated. For example, the insertion of gold radon seeds or needles containing radium or radon into cancers of the tongue, lip, floor of the mouth, rectum, prostate, breast, and axilla, as well as certain tumors of soft parts such as hemangiomas, neurosarcomas, liposarcomas may be done with facility and a minimum of discomfort by the use of sodium evipal anesthesia. It is an ideal anesthetic for dilatation of the cervix uteri, and the placement of radium applicators in the cervical canal and body of the uterus. The anesthesia is of sufficient duration to permit of such operations as suprapubic cystotomy and insertion of gold radon seeds into cancers of the urinary bladder, antrotomy and the placement of gold radon seeds or radium-bearing capsules in the antral cavity for treatment of carcinomas of this location, passage of a radium tandem into the esophagus, or radium-bearing intubation tubes into the larynx. Our experiences with this anesthesia have led us to conclude that it is a most valuable aid to radiologists.

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AN ANALYSIS OF THE CHOLECYSTOGRAPHIC FINDINGS IN 300 CASES, WITH COMPARISON OF THE OPERATIVE FINDINGS IN CASES OPERATED UPON

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THIS paper represents the work done in the average sized department of roentgenology. The patients studied are both charity and private ones, and were referred to us both from the Out-patient Department, and Indoor Medical and Surgical Services of the John Sealy Hospital. Clinically, these patients range from the ones merely complaining of vague digestive symptoms, to the ones presenting typical and definite symptoms of gall-bladder disease.

TECHNIC

Both the oral and intravenous methods of administration are used. We employ iodeikon for oral administration and follow the usual technic. Care is taken as to the making of the films, and each one is viewed as soon as possible, any mistake being corrected at once. Iso-iodeikon is used for intravenous administration, and the usual dose is given by the gravity method. We have never observed a severe reaction following the intravenous administration of this dye, but two of the patients in this series had mild chills. *The dye is administered by the radiologist, and the patient is kept in the department throughout the time consumed by the examination.* This, we feel, is an important point because then we are absolutely sure that the examination is not interfered with by the patient taking food. Blood samples are taken at intervals of thirty minutes and one hour for liver function determination. We prefer to give the dye orally first to all patients and repeat it later intravenously if no shadow is obtained.

CHOLECYSTOGRAPHIC FINDINGS

The oral method of study was used alone in 189, or 63 per cent, of our cases.

Of these, 153, or 51 per cent, were found to be normal. There were two of these cases diagnosed as poor function, and as no intravenous study was done the diagnosis remained doubtful.

Cholelithiasis was demonstrated in 15 cases, or 5 per cent of the series, by the oral method alone. A diagnosis of "pathologic gall bladder" was made in an additional 19 cases in which the viscus failed to be filled with the dye.

In four cases, a negative diagnosis made by the oral route was questioned clinically, but was substantiated by intravenous study. On the other hand, in 9 cases (3 per cent) no shadow was observed after oral administration of the dye, only to be followed by normal findings after giving the dye intravenously. This, of course, can be ascribed to various reasons, some of which are inherent in the method and cannot be avoided. In two cases following oral dye in which the diagnosis was doubtful, a diagnosis of gall-bladder disease could be made by the intravenous method.

In one case in which the gall bladder failed to fill after oral dye, there was only slight filling after the dye was given by vein. In 26 cases (8.6 per cent of the cases studied), the diagnosis of gall-bladder disease was arrived at after the giving of dye by mouth was confirmed by intravenous study. In another case in which a normal shadow with good function was found by the oral method, an intravenous study gave doubtful findings.

In 60 cases (20 per cent), the referring physician requested that the examination be done by the intravenous method. There were several reasons for this, the main one being a desire for quantitative measure of liver function as well as a study of the gall bladder itself. Of these cases, 35 were found to be normal, and 28 diseased.

OPERATIVE FINDINGS

These cases were not all operated upon for gall-bladder disease, but all cases that had a laparotomy done after the x-ray examination, and in which the gall bladder was explored, are included in this series. As nearly as could be determined from the hospital records, of the 300 cases examined only 32 were operated upon. In the only case operated upon for possible gall-bladder pathology, despite a negative roentgen diagnosis, the gall bladder was removed and the pathologist classified the condition as chronic cholecystitis. In six other cases a negative x-ray diagnosis was confirmed. In the two cases studied orally in which there was poor filling, not confirmed by intravenous study—hence diagnosed by us as being doubtful—operation revealed a diseased gall bladder in each instance. One of these had stones in it. Of the oral examinations revealing stones, three cases were operated upon and cholelithiasis was found in each instance. The other pathologic diagnosis made by the oral administration in which the viscus was filled was that of obstruction, due to carcinoma of the head of the pancreas. This was confirmed by operation. Of the pathologic diagnoses made

due to non-filling of the organ (studied only by oral method) seven cases came to operation. All were diseased, three of them containing cholesterol stones as well. In the only case, doubtful by oral method and negative intravenously, that was operated upon, a negative operative diagnosis was made. Seven of the cases studied intravenously and orally, in which a pathologic roentgen diagnosis was made, were operated upon and our findings confirmed. There was one case operated upon in the intravenous alone and negative series which was confirmed. All the cases operated upon in the intravenous and pathologic group, five in number, were found to be pathologic. Stones were found in one-third of all the cases operated on. In one case, an irregular outline that was interpreted as being due to gas in the colon was found on operation to be due to adhesions. This, of course, is a needless mistake, because usually the gas has not the same position in different films, can ordinarily be moved along by manipulation, and certainly if an enema is given and successive films made it can be differentiated. In all the cases operated on in which a diagnosis of adhesions were made these were found at operation.

TABLE I

Method of Study	Results	No. Cases	Percentage	No. Cases Operated upon	Pathologic	Neg	Stones	Adhesions
Oral	negative	153	51	6	1	5	0	4
Oral	doubtful	2	0 66	2	2	0	1	
Oral	stones	15	5	3	3	0	3	
Oral	pathol	19	6 3	7	7	0	3	
Oral	doubtful	3	1	1	0	1		
I V	negative							
Oral	doubtful	2	0 66					
I V	pathol							
Oral	pathol							
I V	doubtful	1	0 33					
Oral	negative	1	0 33					
I V	doubtful							
Oral	pathol	9	3					
I V	negative							
Oral	negative	4	1 3					
I V								
Oral	pathol	26	8 6	7	7	0	4	
I V								
I V	doubtful	2	66					
I V	negative	35	11 6	1	0	1		
I V	pathol	28	9 3	5	5	0		

COMMENT

The part of the technic that we wish to stress is the fact that after giving the dye intravenously we keep the patient in the department until after the examination has been finished. We feel that when this is done the roentgenologist can rely implicitly on the results obtained.

In the 300 cases studied in this series, 205, or 68.3 per cent, were found to be normal. (Two-thirds of the patients referred for cholecystograms will be normal.) Three of these cases have been re-examined at intervals of nine months to one year, and the findings of the first examination confirmed.

Seventeen of the cases diagnosed as being pathologic by cholecystograms were thought clinically to have non-surgical conditions. Acute catarrhal jaundice, cirrhosis of the liver, and syphilitic hepatitis were the most common of these conditions. The liver function was markedly lowered in all these cases in which it was studied.

We were able in the early days of our work to persuade the surgeon in our hospital to remove a few gall bladders showing faint shadows, they were grossly normal gall bladders. Dr A. O. Singleton, Professor of Surgery in the University of Texas, with whom this work was done, told us recently that in his judgment the function can better be determined by cholecystography than it can be judged by inspection at the time of operation. He says also that he has no patience with, nor respect for, the surgeons who are removing these gall bladders that are not frankly and grossly diseased, and that adhesions alone are not an indication for removal.

We cannot agree with Fleming (1) who says "A normal cystogram from a patient suspected of having gall-bladder

disease is not to be interpreted as trustworthy evidence against the presence of such disease." Kirklin (2) also says that in from 12 to 15 per cent of the cases giving normal responses the gall bladder is nevertheless diseased. The pathologist can find microscopic evidence of chronic disease in any gall bladder that is removed from a mature patient, but this does not always mean that the patient's symptoms will be relieved by its removal. We heartily endorse the statement made by Davidson *et al* (3) who say, "We feel that pathology can be diagnosed more definitely by a well done cholecystogram than at the operating table, here, function, as determined by the x-ray, is often more valuable than direct inspection."

SUMMARY

The last 300 cases referred to us for cholecystograms were analyzed and findings presented.

Of the cases, 205 were found to be normal. 32 of the cases were operated upon, and our findings were confirmed in all but one case.

We feel that the cholecystographic findings, after the dye is given intravenously and the patient kept under direct observation until the examination is finished, can be absolutely relied upon, and is probably the most important single point in the technic of handling the patient.

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PANCREATIC CYSTS

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ALTHOUGH well known clinical and pathologic entities, pancreatic cysts are rather uncommon. In a radiologic service of 600 bed capacity, in the last two years we have encountered only the one case here reported. The comparative infrequency of the condition may be judged by the reports in the literature. Up to 1912, in 600 autopsies at Guy's Hospital, Hale-White (1) reported four instances of pancreatic cysts. At the

(1) Retention Cysts, lined with epithelium and caused by obstruction in the pancreatic or smaller ducts or acini

(2) Proliferation Cysts, produced by a proliferation of glandular epithelium followed by accumulation of fluid

(3) Congenital Cysts, often multiple and associated with congenital cysts in the lungs or other organs

(4) Hemorrhagic Cysts, due to hemorrhagic necrosis



Fig 1 Postero-anterior view. The mass fits into the lesser curvature of the stomach, pushing the stomach downward and to the left.



Fig 2 Note the pressure of the mass on the stomach and position of the duodenum, the descending limb ascends riding the top and right side of the mass.

University of Minnesota in four years, 1926-1930 (2), only three cases were encountered.

The following types of pancreatic cysts have been described by Mayo Robson and Cammidge (3)

(5) Hydatid Cysts, associated with similar changes in liver or other organs

(6) Dermoid Cysts

(7) Pseudocysts, usually produced by trauma, and not within the substance of the



Fig 3 Lateral projection Stomach is pushed anteriorly



Fig 4 The transverse colon is pushed down and to the left by the mass

pancreas but usually in the lesser omental sac

These various types of cysts, of course, vary as to their etiologic factors. Some of them, such as the retention, proliferative, and hemorrhagic, are produced by acute and chronic pancreatitis, the latter being of the interstitial type. An overgrowth of fibrous tissue will produce fibrous contraction, with narrowing or stenosis of the ducts, and thus give rise to retention cysts. Pressure on the main pancreatic duct will produce such a cyst. Localized areas of hemorrhagic pancreatitis or trauma may produce hemorrhagic cysts. At the bottom of many of these pancreatic disorders producing cysts may be a chronic cholecystitis or cholelithiasis. Congenital cysts and dermoid cysts are, of course, developmental in origin. Hydatid cysts are due to infestation by the echinococcus and, therefore, they are usually accompanied by an eosinophilia. Pseudocysts are of uncertain etiology but trauma plays a prominent rôle in their production.

Pancreatic cysts may occur at any age, but are seen much more frequently after middle life.

As regards the symptoms, these are very mild and indefinite until the cyst becomes of such size as to produce pressure on contiguous organs. These symptoms, like the roentgen signs, depend upon the part of the pancreas involved, that is, whether it is the head, body, or tail. If the head is involved, there may be pain and jaundice simulating gall-bladder disease or carcinoma of the head, and even if the cyst is large the mass may be mistaken for a large gall bladder. With this there is anorexia, belching, vomiting, and all the other signs suggestive clinically of gall-bladder pathology. In cases in which the body or tail of the organ is involved, we get signs of gastric and/or colonic distress, depending upon the amount of pressure exerted and the organs on which it is exerted. When the cyst is large it can be palpated, and if pressure is great enough it may produce intestinal obstruc-

tion Sugar may or may not be present in the urine Much of the pancreatic tissue must be involved before glycosuria occurs, but it is surprising how much tissue destruction there can be without any sugar in the urine David Smith reports a case in which there was no sugar in the urine, and at postmortem so much of the organ was destroyed that there was no sign of pancreatic tissue

ROENTGEN DIAGNOSIS

It is upon the roentgen examination that one must depend mainly for the diagnosis of cysts of the pancreas Since the pancreas cannot be visualized roentgenologically, one must depend for its diagnosis on the pressure and alterations that it produces on the neighboring contiguous organs which can be made visible by the x-ray Therefore, before one can see the effects of the cyst, it must have attained a size that can produce extrinsic pressure on neighboring organs The organs upon which pancreatic cysts produce pressure and the displacements caused by this pressure will depend upon the portion of the pancreas involved, whether it be the head, body, or tail

When the head of the pancreas is involved it may produce very little evidence of its presence, if small If large, it may produce a widening of the duodenal curve, a diminution in caliber of the duodenum, and extrinsic pressure on the greater curvature of the pyloric end of the stomach

If the cyst involves the head or/and the tail of the pancreas, situated as it is behind the stomach and transverse colon, it will push these organs anteriorly and produce an indentation on the posterior gastric wall and the greater curvature of the stomach

However, in a few cases, and the case here reported is one of these, the stomach is pushed anteriorly, downward, and to the left, and the cyst apparently fits into the lesser curvature side of the stomach The duodenum, instead of taking its usual course downward from the cap, courses upward from the pyloric end and



Fig 5 After operation (note normal position of stomach)

is stretched over the upper and right sides of the cyst The transverse colon is depressed downward and anteriorly

When the cyst is removed or marsupialized, which is at present the recognized form of treatment, the neighboring structures assume a normal position

CASE REPORT

M M, female, aged 59 years, was first sent to the Northeastern Hospital by Dr L S Caplan, on June 7, 1933, in the service of Dr T T Thomas, to both of whom I am indebted for the privilege of reporting this case The admission diagnosis was acute abdomen

The chief complaints were pain, a squeezing sensation in the epigastrium, and blood in the stools

The patient gave the following history She was well until Oct 10, 1928, approximately five years before admission, when she suddenly was seized with an attack of severe pain, like a squeezing sensation She was in bed for four days then felt well enough to be up and around She then remained well until October, 1930, when

she had a similar attack which lasted two weeks. Another attack occurred in December, 1932, which lasted about two months. During these attacks she remained in bed but was perfectly well between them. On the day of admission she was seized with a similar attack at 1 P.M., and was sent into the hospital seven hours later. Blood in the stools was a more recent occurrence, and was noticed intermittently for the last few years. It was particularly marked during constipation and quite often the patient noted alternating constipation and diarrhea.

Physical examination at this admission was negative except for the abdomen. This was distended, and a mass was palpated in the upper abdomen extending two inches to the left and four inches to the right of the midline. It was hard and about the size of a golf ball. The mass did not move with the skin and was not tender. It seemed as if it were part of the lower edge of the liver. She remained in the hospital for three days and was discharged as improved.

On July 23, 1933, she was again admitted to the institution with a similar acute attack. At this time, the mass was apparently larger but not tender and again seemed to be continuous with the liver.

Laboratory findings revealed normal urine, hemoglobin 45 per cent, red blood cells, 2,280,000, white blood cells, 11,000.

An x-ray study of the urinary tract was negative. A gastro-intestinal study revealed a large extrinsic mass pressing upon the stomach, pushing it downward and to the left and apparently fitting into the lesser curvature of the stomach. The cap was larger than normal but regular. The second and third portions of the duodenum were stretched over the upper right side of the mass. The descending limb of the duodenum ascended, and the ascending limb descended. The stomach in the lateral projection was pushed anteriorly by the mass. The transverse colon and hepatic flexure were pushed downward (Figs 1, 2, 3, and 4).

Operation revealed the following. On

July 28, 1933, a mid-line incision (8 in long) was made downward from the zyphoid cartilage, thus opening the abdomen and exposing the liver. There protruded into the wound a large fluctuating mass (as large as a man's head), pushing its way upward between the liver above, and the lesser curvature of the stomach below. It was smooth, uniform in outline, and the wall of it thicker in some portions than in others. Some black liquid blood came up around it. The transverse mesocolon was opened, opening the lesser omental sac, and exposing a cyst of the body of the pancreas. The opening in the transverse mesocolon was closed by suture. Because of the thinness of the cyst in front, a trocar was inserted and a small quantity of black liquid blood escaped. With a large 50 c.c. syringe, 150 c.c. liquid blood was removed. This enabled the opening to be closed by forceps and tied with a suture ligature. The cyst was reduced one-fourth in size. A clamp was applied. The cyst wall was sutured to the rectus sheath and peritoneum of the abdominal wall outside the punctured opening, leaving an area of cyst exposed about 2.5 in. in diameter. The skin was closed by interrupted catgut sutures. Alcohol gauze was applied. An abdominal pad was fastened around the forceps with adhesive. Adhesive was applied above and below the forceps.

On July 31, 1933, the dressings were removed. Kelly forceps were removed, with oozing of the contents of the sac. Forceps were applied and clamped to the projecting wall of the cyst. A cautery was applied and the cyst opened. Dark bloody (chocolate colored) fluid and many clots were expressed from the cyst. An exploring hand in the cyst cavity showed marked reduction in size. Two gauze sponge drains were introduced. Alcohol gauze, dry gauze dressing, and adhesive support at the edges, with a Montgomery binder for gauze, were used.

Post-operative diagnosis was a hemorrhagic cyst of the pancreas.

Culture of the fluid removed from the

cyst was sterile and contained no malignant cells

The patient remained in the hospital for about three weeks and was discharged cured, and has remained well since

Roentgen examination three months later showed a normally situated stomach

duodenum, and transverse colon (Fig 5)

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ACTINOMYCOSIS AND ROENTGEN THERAPY

WITH AN ILLUSTRATIVE CASE

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AS early as 1904, Harsha (1) successfully treated a case of actinomycosis of the jaw with roentgen rays, surgical drainage, and the administration of iodides. Since that time, many observers have reported favorable results when they employed this method of treatment, and most of them have ascribed their success to the use of radiation. Notwithstanding the prevailing opinion that involution of the lesions of this disease is brought about by the action of roentgen rays, the fact that iodides were also administered casts a doubt upon the direct cause of the recovery of the patient, and the question remains unanswered and uncertain (2).

However, it is admitted by all concerned that many cases of actinomycosis are on record which were cured with roentgen rays and surgery exclusively, and that the number of such reported cases is increasing rapidly. This alone should be sufficient proof of its efficacy.

Furthermore, there is an established unanimity of opinion on this point by the following observers: Zeisler (3), Steinkam (4), Prickul (5), Smith (6), Desjardins (7), Archer (8), and others. All of them demonstrate the effectiveness of irradiation, and most of them believe that this method of treatment is not only indicated in this disease, but that it is also superior to any other measures.

Nevertheless, it is not the purpose of this article to prove by clinical evidence or otherwise that roentgen therapy should remain the sole factor in the treatment of this disease. There is no denial that surgical incision and drainage, combined with the internal administration of large doses of iodides, are quite often very effective. This is particularly true when

such treatment is continued for a long period of time (9). Even the absorption of the suppurative foci, and the discharge of the specific infectious agent from the tissues may be brought on by the effect of iodides and surgical drainage. But, as a rule, this can occur only in fairly mild cases, and when the patient has taken immense doses of iodides.

NATURAL HISTORY AND PATHOLOGY OF ACTINOMYCOSIS

This disease being quite rare, it may not be out of place to review briefly some of the salient features of this affection that may have to be considered during the treatment.

Actinomycosis is a disease of man or cattle, which is manifested by a suppurative and inflammatory process, with abscess formation. It is characterized by the production of a large amount of granulation as well as the formation of connective tissue. The specific micro-organism, *Actinomyces bovis*, is usually found within the lesion. It is a vegetable parasite, which was discovered by Bollinger (10), in 1877, in the ox. In both man and animal, the naked eye appearance of the parasite within the tissue can be easily detected as a white or greenish granule, the size of a pin-head. When pus has not been formed, it lies embedded in the granulation tissue. Under the microscope, it appears to be composed of threads which radiate from a center and presents bulbous or club-like terminations that are typical of *Actinomyces bovis* (11).

Essentially, the pathology is a chronic process which results, as noted above, in abscess formation and tissue destruction, plus connective tissue growth and the formation of granulation. Quite often, the newly formed tissue simulates a neo-

plasm Due to their chronic suppurative process, the lesions are frequently classed among the infective granulomas This is an important feature to the radiologist, for to some extent it explains the radiosensitivity of the lesion and *ipso facto* renders it suitable for irradiation A further discussion of this point will be found subsequently Extension of the actinomycotic process takes place by continuity Metastases rarely occur through the blood stream, and the disease is hardly ever transported by the lymphatics The most frequent site for actinomycosis is the cervicofacial region (12 and 13)

BIOLOGIC EXPLANATION OF THE EFFECT OF ROENTGEN RAYS ON ACTINOMYCOSIS

The exact action of roentgen rays on the lesions of actinomycosis is not known Some are of the opinion that, inasmuch as patients suffering from this disease as a rule take a large amount of iodides daily, it stands to reason that the diseased areas accumulate iodine in the tissues In this way the effect of the rays becomes greatly enhanced because the presence of the iodine gives rise to secondary radiation (14) Others believe that the action of the rays produces a liberation of nascent iodine, which has a highly deleterious effect on the organism in the tissue Both of these theories are questioned by many radiologists (15)

On the other hand, it has been demonstrated by experiment on cultures of actinomycosis *in vitro* exposed for a sufficient length of time to amount to ten erythema doses, that roentgen rays had no lethal effect on the micro-organism except retardation of growth for several days (16) This is very much in line with the literature dealing with experiments on other micro-organisms, including bacteria and protozoa as well as vegetable fungi Theoretically, it is generally accepted that the efficacy of radiation in actinomycosis is brought about by the indirect action of the rays which most likely injures or so modifies the tissues as to render them poor media for the organism to grow In all

probability, the indirect effect of radiation may play an important rôle in many affections (17)

It is also claimed that the most important factor that produces a favorable action of the rays in actinomycosis is the high degree of radiosensitivity of the lesion This disease belongs to one of the groups of non-bacterial infective granulomas which is exceedingly susceptible to radiation MacKee calls our attention to the principle that radiosensitivity bears some relation to duration and activity He said "The rapidly developing granulomas, actinomycosis, blastomycosis, granuloma annulare, and miliary lupus involute more rapidly under irradiation than those of slow evolution "

There are some who suggest that the recovery of irradiated cases in actinomycosis is due to an increase in the complement fixation powers of the blood serum which is brought about by the rays However, there are serious objections to this theory It is generally known that, when we irradiate patients suffering from furunculosis, there is a gradual decrease in the number of fresh lesions cropping up from time to time This most likely indicates an increase in the complement fixation effect But no one has ever noted or recorded similar phenomena during the treatment of actinomycosis On the contrary, Dykes (18) has observed that actinomycosis takes a special position among the inflammatory disturbances in that it requires much larger quantities of roentgen energy than other inflammatory conditions He reached this conclusion from the large doses that had to be administered in order to obtain the desired effect In the same manner it was observed by the writer of this paper that, during the course of treatment of the illustrative case herewith reported, there was no general diminution in the number of new lesions appearing, nor were they less severe before more than one-half of the number of treatments were given Not until eight treatments were administered (each delivering one-third of an erythema dose on each lesion properly

spaced as to time and area), was there any mitigation in the severity of the signs and symptoms of the disease

the same side presented dusky-red circumscribed swellings. They were painless or slightly painful, and consisted of granula-



Fig 1 Photograph taken at the beginning of radiation therapy

REPORT OF THE CASE

The patient, a male, 42 years of age, a native of the British West Indies, was admitted to the hospital on April 2, 1934, with a swelling on the right side of the face. After a careful history, and physical and laboratory examinations, no definite diagnosis was made until May 1, 1934, when the swelling was incised for the purpose of examining the contents thereof. The bacteriologic examination resulted in finding the ray fungus *Actinomyces bovis*; this clinched the diagnosis.

The patient was transferred to the department of surgery under the care and service of Dr. M. Bodenheimer, who incised and drained all lesions as they appeared from time to time. He also prescribed potassium iodide, and ordered roentgen therapy.

The disease involved the head and neck. The buccal cavity was most likely the portal of entry for the infective agent. The infection came on after an extraction of a right molar. The submaxillary region was the primary seat of the disease. The region of the masseter muscle on the right side as well as the parotid gland on

tion and connective tissue. The lesions may be further described as multiple abscesses which were encapsulated. They were slowly advancing, indolent and indurated swellings. Their tendency to break down in multiple areas resulted in forming communicating channels, discharging sinuses and fistulas. At the acme of the disease, the inflammatory infiltrations were so excessive that they appeared like brawny indurations or sarcoma-like infiltrations.

Extension of the lesions took place as high up as the upper lid and outer canthus of the right eye, while extension downward continued along the right side of the neck to within a half-inch of the right clavicle.

Roentgen therapy was administered to all lesions of the head and neck, delivering a third of an erythema dose on the seat of the disease once or twice weekly, properly spaced as to time and area, during a period of 69 days. Other factors were 140 K V, 5 ma, filter, 4 Al.

The patient was discharged on July 16, 1934, ten weeks after the diagnosis was established, but was instructed to continue the treatment of the resultant keloids in the out-patient department of the hospital.

ILLUSTRATIVE CASE DEMONSTRATING THE NECESSITY OF A SPECIAL RADIATION TECHNIC

The fact that extension of the disease takes place more often by continuity than through the blood vessels and lymph channels has a marked bearing upon the technic of radiation of this condition. This was clearly brought out during the treatment of the illustrative case herein described. Whenever the patient was irradiated it was found that the pathologic structure within the area coinciding with the palpable borders of the lesion had actually disappeared within ten days. In the meantime, however, new lesions had developed contiguously, but outside of the field that had been treated. This apparently indicated that the actinomycotic granuloma had extended by continuity beyond the palpable border before the treatment had been administered. It also showed that the pathologic structure outside of the palpable area was at that time so recent that it naturally was undetectable by the ordinary physical methods of examination. Not having been discovered before the treatment was instituted, the newly formed lesions failed to obtain radiation because they were excluded from the beam of rays.

In order to overcome this difficulty the writer came to the conclusion that in the treatment of actinomycosis it is not sufficient to irradiate a field that will cover only the entire diseased area, for very often the lesions in this affection had extended beyond the palpable border, even though no recognizable evidence could have been detected by physical examination.

Therefore, it is incumbent upon the radiologist to provide for probable early extension of the lesion in all cases of actinomycosis. The best practice is to map out fields for irradiation that will extend from 2 to 5 centimeters beyond the palpable borders of the lesion. Similarly, when dealing with deep-seated lesions, the quality of the rays should be sufficiently penetrating to reach not only the recog-

nizable depth of the actinomycotic granuloma, but they should also have the quality of penetrating 2 or 3 centimeters beyond that depth in order to provide for the probable growth or extension of the lesions.

ILLUSTRATIVE CASE INDICATING THAT HYPERTROPHIC SCARS OR KELOIDS RESULTING FROM ACTINOMYCOSIS ARE RADIOSENSITIVE

Hypertrophic scars and keloids, resulting from lesions and incisions of actinomycosis, are unsightly and highly disfiguring, and are particularly distressing to the patient when the disease had involved the cervicofacial region. Quite often they cause distortion and displacement of the soft parts of the nose, mouth, and eyelids. Both spontaneous keloids and hypertrophic scars have been generally considered to be radioresistant structures, but at present it is known that hypertrophic scars (such as are found in the sequelæ of actinomycosis) are covered only by a thin layer of epithelium, and require a much smaller number of exposures than in the case of spontaneous keloids. We should also keep in mind that the more recent the keloids and hypertrophic scars are, the more rapidly will they involute or entirely disappear when irradiated. In this case we continued irradiation after the actinomycotic process was completely arrested.

We administered 50 per cent of an erythema dose weekly upon all scars and keloids, using 150 K V, 5 ma, 4 A1. The results are gratifying (Figs 1, 2, and 3).

METHODS AND FACTORS OF RADIOTHERAPY

The protracted fractionated method of roentgen irradiation in actinomycosis has lately been tried by R. Stewart-Harrison (19), of the University of Zurich. Thirty cases have been treated during a period of time between the years 1922 and 1933. Twenty-two of these cases had received radiation in accordance with the old technic, which consisted of the administration of the simple fractionated dosage, while eight cases received the benefit of the newer

protracted fractionated method of Cou-tard. Complete recovery took place in all cases, but patients that had been treated

the accumulation of the high intensities of radiation. Furthermore, the cosmetic re-sults of the old method were not equally as



Fig 2 Photograph taken nine weeks after first treatment was given



Fig 3 Photograph taken at the conclusion of all treatments including radiation, for keloids and hypertrophic scars

by the old method often required a second series of treatments, which in a number of cases resulted in skin damage because of

good as when the protracted fractionated technic had been used

The technic was described as follows

One treatment was administered daily on successive days, the factors being 170 K V , filter 1.3 mm Cu, 60 cm distance, 2.5 to 3.5 r, were delivered per minute, 240 r per dose. Total dose varied from 1,200 to 1,500 r.

On the other hand, E. G. Smith (20) believes that those cases which received large initial doses made the most rapid recoveries. He further states that the quality of the rays (wave length) in cervicofacial patients seemed to have little or no bearing on the outcome. This is probably due to the fact that the depth of the infection in these cases is hardly ever more than 3 or 4 centimeters. He advises, however, the following technic: 800 r (1 E.D.) deep therapy, generated at 200 K V peak, using a filter of 0.5 mm Cu, plus 4 mm celluloid or its equivalent in some other filter, the dose to be administered at intervals of one or two weeks.

Archer and Barker (21) describe their technic as follows: the voltage varies from 132 K V to 200 K V peak, filtration varies from 1 mm Al to 0.5 mm Cu plus 1 Al, depending upon the location of the lesion and the quality of the rays necessary to reach its depth. A sufficient number of portals are used to secure the equivalent of one-half of an erythema dose in the depth at the site of the lesion, the number of roentgens depending upon the quality of radiation.

SUMMARY

1. There is a unanimity of opinion that surgical drainage together with roentgen therapy can bring about a complete cure in actinomycosis without the administration of iodides. However, when iodides are given in large doses and for a long period of time, they may also be very effective.

2. It is generally accepted that the efficacy of irradiation in this disease is brought about by the indirect action of the rays, which alters or so modifies the tissues as to render them poor media for the growth of micro-organisms. Whether the changes produced in the tissues are physical, chemical, or biologic is not known.

3. Another contributing factor which aids the favorable action of the rays is the high degree of radiosensitivity of the lesions in this affection.

4. Because the mode of extension of the disease takes place more often by continuity than through the blood vessels and lymphatics, the author found it necessary to use a special radiation technic, which has been described.

5. The results of the treatment of the illustrative case are satisfying from the standpoint of being a complete cure and free from any residual keloids or disfiguring scars.

6. Hypertrophic scars resulting from actinomycosis are covered by a thin layer of epithelium, and therefore require a much smaller number of roentgen-ray exposures than in the case of ordinary spontaneous keloids.

7. The technic of radiation therapy in this disease apparently varies with each author. The quality of the rays ranging from 95 to 200 K V, filtration from 4 mm aluminum to 1.3 mm Cu. Intensities range from 200 r to 800 r. Some use the larger initial dose method, others rely on the simple fractionated dosage, while still others administer the protracted fractionated technic. However, all apparently report highly satisfactory results.

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URETERAL OBSTRUCTION IN CARCINOMATOUS CERVIX¹

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From the Brooklyn Cancer Institute, Dr Ira I Kaplan, Director

DURING the last four years we have been intensely interested in the urologic complications of late carcinomatous cervix.

In going over 27 consecutive autopsy records of carcinomatous cervix in patients who died on our service, we found that ureteral obstruction with associated renal damage occurred in 22 of the cases, and in only five patients did distant metastasis have the opportunity to develop.

Carcinoma of the cervix, as you know, may extend in one of three ways, namely, either posteriorly, with invasion of the rectal wall, anteriorly to the bladder wall, or laterally into the broad ligament. With posterior extension, the symptoms are rectal pain, obstipation, tenesmus, and rectal bleeding. With extension to the bladder, dysuria, frequency of urination, and hematuria are the important signs. Here differentiation must often be made from an old radium burn, since practically all of these cases have had intensive radium therapy. Cystoscopic examination in late carcinoma of the cervix with anterior extension will often reveal large masses of bullous edema with areas of papillary projections and, finally, the formation of a vesico-vaginal fistula. However, the greatest number of cases in our series presented themselves with signs and symptoms of ureteral obstruction. Usually, the patient complains of a constant dull pain located deep in the groin, referred to the thigh and leg, and often simulating an attack of sciatica. The pain may be referred to the sacrum, simulating sacro-iliac disease, or, what is most common, to one or both kidneys, especially when complete occlusion of the ureter has taken place.

As infection intervenes secondary to this obstruction, and its associated urinary stasis, chills and fever commonly occur, with anorexia, general malaise, and prostration. The urine often is turbid. However, with complete unilateral occlusion, the urine may be persistently clear, although evidences of a large hydronephrosis are present. Gastro-intestinal symptoms are usually pronounced and are associated with the hydronephrotic condition which is present.

This type of patient often develops a marked distaste for food, we have had patients gain from 10 to 100 pounds after the obstruction has been removed and their appetites have returned.

Physical examination with the finger in the rectum or the vagina reveals some degree of induration of the parametria. However, cystoscopy and ureteral catheterization establish the diagnosis very positively.

We have found these obstructions to be unilateral in about 75 per cent of the cases. Ureteral catheterization meets with obstruction in the terminal portion of the ureter, and in most cases nothing will go by the point of obstruction, and sodium iodide injected through the catheter for ureteral pyelography will regurgitate back into the bladder. In a few cases we have been able to overcome this obstruction by the passage of filiforms, and in these cases we have allowed the catheter to remain *in situ* for from 24 to 48 hours. These cases were followed up and the ureter dilated at weekly intervals. In several of our cases, although the obstruction could be overcome, the infection could not, and removal of the infected kidney was decided upon and successfully performed. The cases with complete unilateral obstruction were nephrectomized, and in each case the improvement was immediate and lasting. We have

¹ Read before the Annual Conference Division of Cancer Department of Hospitals City of New York April 10 1935

nephrectomized five consecutive cases of this type without an operative mortality

In bilateral obstruction and infection the

showed no evidences of hydronephrosis) Third, we considered the results of our own operative findings In each of our cases of



Fig 1 Retrograde pyelogram showing a normal pelvis and ureter on the left, and complete obstruction to the lower ureter on the right Sodium iodide on the right would not go past the point of obstruction and regurgitated back into the bladder



Fig 2 Section from tissue removed at the point of obstruction reported as epidermoid carcinoma

problem is, of course, a much more difficult one We have operated upon three cases with bilateral hydronephrosis In two of these the ureters were transplanted into the bowel, and in the other case a transplantation of the ureters into the loin was done

A word as to the etiology and mechanism of ureteral obstruction As these cases came up for discussion in our clinic, many of the men felt that excessive radiation therapy was the important factor in the formation of reactive scar tissue with secondary occlusion of the ureter, inasmuch as all our cases had received some form of radiation therapy over a rather long period of time Against this point of view is, first, the work of Thibaudeau and others, who have reported cases of bilateral hydronephrosis in which no radiation therapy had been given, second, the experimental work of Martin and Rogers, who, in investigating the effect of radiation therapy on the ureter, applied radium capsules directly to the ureter and studied the effects of one and a half and two and a half erythema doses (In no case was any stricture produced, and pyelograms performed after the kidneys and ureters had been removed

unilateral obstruction of the ureter, the lower ureter was first explored by an anterior incision and found to be embedded in a mass of tissue which, on examination, was found to be carcinomatous in character

I should like to present a few illustrative cases The first patient I wish to report was a white female, 39 years of age, who was admitted on our service in March, 1932, with a chief complaint of pain in the right lower quadrant of the abdomen A week prior to her admission to the hospital, the patient had been seized with a similar pain and a diagnosis of acute appendicitis was made by her family physician She had been treated for carcinoma of the cervix since the onset of her vaginal bleeding in December, 1930 Biopsy report at that time showed the presence of an anaplastic epidermoid carcinoma of the cervix, she had been receiving radiation therapy in large doses since that time Associated with the pain in the right lower quadrant, there was some vomiting, marked distaste for food, and a loss of 20 pounds in weight

Cystoscopy showed a normal-appearing bladder mucosa and no evidence of vesical encroachment The left ureter was catheterized to the pelvis without evidence of ob-



Fig 3



Fig 4



Fig 5

Fig 3 Intravenous urogram showing a normal pelvis and ureter on the right, and a complete loss of function on the left.

Fig 4 Retrograde pyelogram showing a normal pelvis on the left, and a large hydronephrosis on the right. In this case the obstruction to the lower ureter had been overcome, but nephrectomy was necessitated because of severe infection.

Fig 5 Retrograde pyelogram showing a large infected hydronephrosis. In this case the obstruction to the lower ureter was relieved by ureteral dilatation, but severe infection necessitated nephrectomy.

struction, and the urine obtained from this side was clear. On the right side, an obstruction which could not be passed was met about three centimeters from the vesical orifice. Indigo-carmin injected intravenously returned in four minutes on the left side, while no return of the dye was noted at the end of thirty minutes on the right side. Retrograde pyelography (Fig 1), revealed the presence of a normal kidney pelvis and ureter on the left side, while on the right side no sodium iodide would pass the point of obstruction, and was seen to regurgitate. Intravenous pyelography revealed a normal pelvis on the left side and no visualization of the renal pelvis on the right side.

On May 18, a right anterior incision was made, and the ureter explored extraperitoneally. The ureter was greatly dilated above a point of obstruction, at which it was found embedded in a mass of carcinomatous tissue. A section of this tissue (Fig 2), was removed and the ureter tied above the point of obstruction. The patient was then turned over on her side and a complete nephro-ureterectomy performed.

Her post-operative course was uneventful and she was discharged on June 16, 1932. Her general condition has improved markedly, and when last seen—about six

months ago—she had gained 40 pounds in weight and was free from pain.

The second case is a white woman, 45 years of age, with a carcinomatous cervix that was treated by x-ray and radium since the onset of her vaginal bleeding, in 1930. She was referred to me in November, 1933, and at this time was complaining of pain in the left groin and pelvis, radiating to the left leg. This was associated with nausea, vomiting, and a loss of weight. Again, cystoscopy revealed complete obstruction of the left lower ureter and a functionless kidney on this side (Fig 3). A section of tissue surrounding the lower ureter was removed and found to be carcinomatous in nature, then the patient was nephrectomized. She is alive, well, and free from pain.

The third case is a white woman, 37 years of age, who was admitted to the hospital Jan 10, 1933, complaining of pain in the left groin, radiating to the leg and back, associated with chills, fever, and dysuria. There was marked tenderness over the left lumbar area, with definite evidences of muscular spasticity. The urine was turbid and was found, on microscopic examination, to contain much pus. This patient had been treated for a carcinoma of the cervix since the onset of her symptoms, in 1930. Her temperature was 103 degrees. On rectal ex-

amination, marked induration could be felt on the left side. A diagnosis of left ureteral obstruction, with an associated infected hydronephrosis, was made.

On cystoscopic examination, an obstruction was met about five centimeters from the vesical orifice. This was overcome and a catheter was passed to the pelvis. The urine from this side was purulent and under pressure. Indigo-carmin injected intravenously returned in three minutes on the right side in good concentration, while no return of the dye was noted at the end of thirty minutes on the left side (Fig. 4). The left catheter was left *in situ* for drainage. The following day the temperature dropped to 100 degrees, and after four days the catheter was removed. After removal of the catheter the temperature again rose to 104 degrees, and there was marked tenderness over the left kidney. Surgical intervention was decided upon, and on March 14 the left kidney was explored, it showed evidences of a pyonephrosis and was removed.

The convalescence was uneventful. The patient was discharged from the hospital on April 10, in good condition. Her urinary symptoms have subsided and her pain has disappeared. When last seen she weighed 190 pounds, a gain of 100 pounds since the time of operation.

The next case is that of a white female, 50 years old, who was admitted to the hospital May 8, 1933, with severe pain in the right groin, radiating to the right leg, hip, and back. The patient had been running an irregular septic temperature for several weeks prior to admission. With this, she complained of a distaste for food, gaseous distention, nausea, vomiting, and general prostration. The patient had been under observation since Jan. 19, 1932. She was found to have had a definite carcinomatous cervix, and had received several cycles of radiation therapy since that time.

Cystoscopic examination at the time of admission revealed an obstruction in the

lower right ureter. This was overcome and the ureter catheterized to the pelvis. The urine was under pressure and purulent in character. There was no obstruction on the left side, and indigo-carmin injected intravenously returned in four minutes in good concentration on this side, while on the right side only a poorly concentrated dye appeared at the end of twenty minutes. The catheter was allowed to remain *in situ* and irrigated with boric acid every three hours. Following the withdrawal of the catheter, the temperature again rose and was associated with severe pain in the right lumbar area.

Surgical exploration was decided upon, and on June 8, 1933, a right nephrectomy was performed (Fig. 5). The kidney showed evidences of an infected hydro-nephrosis.

The patient made an uneventful recovery and was discharged July 1, 1933. She was last seen Sept. 15, 1933, at which time the pain had disappeared, her general condition had improved, her appetite was good, she had gained 15 pounds in weight, and was able to attend to her household duties.

SUMMARY

We feel that the intense suffering of patients with carcinoma of the cervix late in the disease is caused in very many cases by broad ligament extension, with ureteral obstruction. This process progresses until complete obstruction of the ureters, secondary renal infection, and death from uremia ensue.

The cases presented illustrate very definitely what can be accomplished when the condition is recognized. Repeated cystoscopies and pyelograms are most important in the follow-up treatment of carcinomatous cervix so that extension to the ureter can be recognized early and treatment instituted before complete obstruction occurs.

TREATMENT OF CARCINOMA OF THE BLADDER WITH RADON TUBES¹

By ASA B. FRIEDMAN, M.D., *New York City*

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CARCINOMA of the bladder that progresses beyond the realm of simple urologic surgery has never been a too satisfactory field for the radiologist. Reports of excellent results with the use of interstitial radiation, gold seeds, such as reported by Barringer, and results with x-ray therapy, such as recently reported by Pfahler, make excellent and encouraging reading. However, in my own experience and in the experience of the urologists with whom I am associated, the results have been, even when following as nearly as possible the prescribed technics, not nearly so satisfactory as others report.

For clinical purposes carcinoma of the bladder may be divided into two main groups: first, the papillomas, single or multiple, which are to be considered either definitely malignant or premalignant; secondly, the flat or surface carcinoma of the bladder wall. Further pathologic classifications are of deep academic interest but of little immediate value in the actual treatment of the patient. The first group—the papillomas—when seen reasonably early, while the lesion is fairly localized, give moderately satisfactory results with electro-surgery alone. In other words, when there is a narrow pedicle, it can be cut through and its base fulgurated, then the patient stands a good chance of recovery. The second group, namely, the flat infiltrating lesions of the bladder wall (those having no pedicle or stump), present a totally different problem. The surgical results in such cases are not nearly as satisfactory. In these cases gold seeds have been widely advocated and the good results obtained by Barringer and others have been reported. Our own results, as

already stated, were not encouraging. Attempting to analyze the reason for not being able to reproduce the cures claimed by others, only one factor presents itself. After all, we must assume that the type of patient is the same and the radon used is equally effective. Therefore, it seems logical that we must have experienced difficulty in obtaining proper distribution of dosage. In order to increase filtration and to get more homogeneous irradiation of the tumor, we planned to use platinum-filtered radon or radium tubes peripherally around the lesion. To date we have treated three such cases. The case herein reported is the first one in which this method was used.

H. V., an Italian male, aged 50 years, was admitted to the hospital on the service of Dr. Charles Cochrane, on March 16, 1931. He gave the typical story of many months' progressive dysuria, tenesmus, and hematuria. Cystoscopy, pre-operatively, showed a large, fungating, ulcerated growth on the roof of the bladder. Diagnosis of carcinoma of the bladder was made. X-rays of the lungs and osseous systems were negative. On April 10, 1931, a suprapubic cystostomy was done. The tumor was a flat papillary lesion situated on the anterior bladder wall, largely beneath the symphysis pubis but extending somewhat laterally toward the right. It measured about 3.5 by 4 centimeters. Besides removing a portion of the lesion for biopsy, Dr. Cochrane fulgurated the superficial portion. Four platinum tubes of radon were then fastened about the periphery of the lesion. A single absorbable catgut suture was used to hold each tube. The needle was passed through the bladder wall just distal to the macroscopic margin of the tumor and was tied around the radon capsule. A long black

¹ Read before the Annual Conference, Division of Cancer, Department of Hospitals, City of New York, April 10, 1935.

silk thread attached to each capsule was allowed to pass through the abdominal wound and was strapped to the abdominal wall. Four capsules so fixed were further kept in place by packing the bladder with ordinary gauze packing. The four capsules together contained 22 mc of radon and the walls had a filtrating value of 1 mm platinum. The suprapubic wound was closed in the usual manner. A suprapubic catheter was inserted. The radon was removed one week later. No difficulty was experienced in removing the capsules after the packing was withdrawn. There was no further bleeding at the time of the removal of the radon. The total dose used amounted to 15.9 mc destroyed or an equivalent of 2,114 mgm-hr of radium element. The patient remained in the hospital for a few months. He developed a severe neuritis of a part of the sacral plexus, pain, and even motor disturbances in the right thigh. We felt that these possibly signified a radium injury and that we had been unfortunate enough to have attached a radium capsule too close to one of the nerve trunks. However, this condition cleared up and further

progress was uneventful. Repeated cystoscopic examinations since then have shown total disappearance of the tumor, and up to his last visit a short time ago, four years after the radium insertion, there have been no recurrences. The general condition of the patient, subjectively and objectively, is entirely normal. Cystoscopy at this date reveals no evidence of recurrence.

Although one successful case of four years' duration is not conclusive, yet we feel that there are the following certain advantages in this method of applying radium over interstitial implantation: (1) amount of trauma in bladder is less, (2) filtration used is much higher, (3) distribution of dose is more satisfactory.

A disadvantage of the method is that in certain instances considerable technical difficulties are experienced in sewing the radon capsules into the bladder wall.

The use of this method must be limited to selected cases in which the lesion is not too far advanced. It may be advisable to do the procedure in two stages, first, a suprapubic drainage for a week or more, and second, reopen and apply the radon.

A CASE OF SARCOMA OF THE ANTRUM, COMPLICATED BY PREGNANCY, TREATED BY IRRADIATION¹

By ALBERT KEAN, M D , *New York City*

From the New York City Cancer Institute, Dr Ira I Kaplan, Director

THE patient, a white female, 29 years of age, housewife, born in the United States, was admitted to the Cancer Clinic on May 5, 1933, complaining of pain in the left upper gum, swelling of the left cheek, and loss of weight (15 pounds in five months)

Her present illness had started with

that area. Having had no relief, she went to another dentist, who extracted some more teeth.

Because her condition did not improve following this treatment, the patient went to a city hospital for advice in April, 1933, at which time there had developed a small growth on her gum. A small piece of this



Fig 1-1



Fig 1-B

pain in the left upper gum six months prior to her admission. She had consulted her dentist, who extracted several teeth from

growth was removed for diagnosis at this hospital. She was then referred to the Cancer Institute. The biopsy report was spindle-cell sarcoma.

There was nothing in the past history relevant to the present condition.

¹Read before the Annual Conference, Division of Cancer, Department of Hospitals, City of New York, April 10, 1935.

silk thread attached to each capsule was allowed to pass through the abdominal wound and was strapped to the abdominal wall. Four capsules so fixed were further kept in place by packing the bladder with ordinary gauze packing. The four capsules together contained 22 mc of radon and the walls had a filtrating value of 1 mm platinum. The suprapubic wound was closed in the usual manner. A suprapubic catheter was inserted. The radon was removed one week later. No difficulty was experienced in removing the capsules after the packing was withdrawn. There was no further bleeding at the time of the removal of the radon. The total dose used amounted to 15.9 mc destroyed or an equivalent of 2,114 mgm-hr of radium element. The patient remained in the hospital for a few months. He developed a severe neuritis of a part of the sacral plexus, pain, and even motor disturbances in the right thigh. We felt that these possibly signified a radium injury and that we had been unfortunate enough to have attached a radium capsule too close to one of the nerve trunks. However, this condition cleared up and further

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A disadvantage of the method is that in certain instances considerable technical difficulties are experienced in sewing the radon capsules into the bladder wall.

The use of this method must be limited to selected cases in which the lesion is not too far advanced. It may be advisable to do the procedure in two stages, first, a suprapubic drainage for a week or more, and second, reopen and apply the radon.

and tissues of the left maxilla. There is exposure of bony sequestra. Biopsy should be taken from the growth in the nose." This was done and the pathologic report was "round-cell sarcoma."

On July 25, 1933, the treatment advised was as follows: Cleaning out of left antrum and packing with radium tubes (2,000 mc-hr).

The patient was then admitted to the Cancer Hospital for operation, but because she developed high temperature this was not carried out. Another course of high voltage x-radiation was decided upon.

On Sept 11, 1933, an examination by the nose and throat service again showed



Fig 4



Fig 5 A



Fig 5-B

"marked improvement, small sequestrum removed from left maxilla and gingival margin."

At this time the patient was advised to return in about four weeks for further examination, but she did not keep her appointment. When she finally did present

herself on Nov 21 her condition had taken a bad turn. She had a great deal of pain, had lost some weight, and she stated that she had missed two menstrual periods since the last examination. An Aschheim-Zondek test was reported positive, and the patient was advised to have the pregnancy



Fig 2

gum was replaced by a vascular growth which bled very easily. The second molar was still present, and part of the hard palate was found to be infiltrated with newgrowth. There also were present small glands in both submaxillary areas.

Roentgen examination of the sinuses, made on May 11, 1933, showed cloudiness of the left antrum.

A course of high voltage x-ray therapy to the lesion was advised, it was completed on June 13, 1933.

A follow-up note made by the examining surgeon on June 28, 1933, was as follows: "A tumor mass beginning in the mucous membrane of the left upper gum is present. There is an ulceration, which is about two inches long. This examination shows a marked subsidence and marked diminution of the growth." Review of the original slide by our laboratory revealed an "inflammatory condition."

The patient was again seen on July 11,



Fig 3-A

Examination on the day of admission, May 5, 1933, revealed a swelling of the left maxillary area, and the entire left



Fig 3 B

and the following note was made: "There is fleshy growth in the left nostril, swelling over the left cheek and mucous membranes

and tissues of the left maxilla There is exposure of bony sequestra Biopsy should be taken from the growth in the nose" This was done and the pathologic report was "round-cell sarcoma"

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Fig 5-B

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herself on Nov 21 her condition had taken a bad turn She had a great deal of pain, had lost some weight, and she stated that she had missed two menstrual periods since the last examination An Aschheim-Zondek test was reported positive, and the patient was advised to have the pregnancy

interrupted by x-ray treatments, but she declined it for religious reasons

Another course of high voltage x-ray treatments was given to the tumor, which had grown considerably larger, and on Feb 3, 1934, further increase in the growth was noted, in spite of more intensive treatment

On April 11, 1934, there was "marked extension of the process. Hospitalization is advised, and application of radium pack, as high voltage does not seem to affect the growth any longer"

Roentgen examination of the sinuses showed destruction of the floor of the left antrum

A wax mold designed by the resident therapist, Dr Marks, was continuously applied from April 18 to April 23, interrupted only for short intervals for the cleansing of the applicator, it contained radon tubes at 15 in distance with 4 mm lead filter, provided with a lead shield for the protection of the eye. The total dose of a little less than 20,000 mc-hr was delivered

A marked improvement was noticed immediately after removal of the mask, and the patient was discharged on April 26. There was no complication in the progress of pregnancy. The patient gave birth to a normal baby in July, and presented herself on August 7 at the Cancer Clinic for a follow-up examination. The following note was made: "Patient's general condition is excellent. There is no evidence of local recurrence. There is a draining sinus, however, in the roof of the mouth at the junction of the alveolar ridge and the cheek. There is no evidence of metastasis"

On March 13, 1935, the patient's general condition is still excellent. She has gained a great deal of weight. Through the aid of the dental department, a plate was made and fitted well over the defect in the roof of the mouth. No further therapy is required. One year after the radium had been applied there were no signs of disease, and the baby was perfectly normal

On May 2, 1935, roentgen examination of the sinuses showed "definite clearing and repair of the destruction previously reported in the floor of left antrum"

SUMMARY

This case is presented to emphasize the following points

- (1) A very radiosensitive tumor responding to high voltage radiation becomes radioresistant, coinciding with patient's pregnancy, the condition growing rapidly worse and seemingly hopeless
- (2) Radium application, which was advised with the hope that the tumor would still respond to radium, high voltage x-ray having failed, proved to be successful
- (3) The excellent response in this case in spite of the pregnancy demonstrates that no condition should be considered absolutely hopeless, and that it is well worth while attempting treatment even in such cases
- (4) There was no interference with the progress of the pregnancy and the baby is developing normally
- (5) The patient has been free from disease for more than a year after the radium application

CUSTODIAL CARE OF CANCER PATIENTS¹

By ABRAHAM LIEFF, M D , *New York City*

From the New York City Cancer Institute, Ira I Kaplan, M D , Director

THE custodial care of cancer patients is, in the minds of many, limited to the care of these patients only when they have reached the stage beyond surgical, radium, or high voltage therapy. It, however, includes the treatment of less advanced cases, whose general condition is impaired either as a direct result of the malignancy from which they are suffering, or from some allied or complicating disease. These patients often require prolonged hospitalization and medical care before recognized and specific treatment may be successfully undertaken. Then, there is the borderline class of patients, in these, the neoplastic condition has advanced so far that it is difficult to decide, without careful study and observation, whether it is amenable to surgical removal or radiation therapy. Lastly, the post-operative cases which were initially treated at some city or private hospital for acute cases, and which must remain hospitalized for a relatively long period of time in order to complete their post-operative care, or receive further treatment before they are discharged home, are adequately cared for at the Cancer Hospital on Welfare Island.

Patients admitted to the Cancer Hospital come as transfers from other city institutions, where the number of beds available for chronic patients is limited, and where the turnover is too large and too rapid to permit of keeping patients over a specified period of time. Even when these hospitals possess the necessary equipment for the treatment of cancer patients, their bed capacity is limited. In order to make room for new admissions, they find it necessary to send their chronic patients to Welfare Island for continuation of treatment already instituted, or for any type of general

treatment that may be indicated in each individual case.

Private hospitals lacking facilities for radiation therapy, particularly in the case of patients unable to pay the high cost such treatment entails, send their patients to the Cancer Hospital.

Private physicians, when a case suffering from malignant disease is brought to their attention or is discovered by them in the course of daily practice, find the Cancer Hospital the only place where such a patient can find a bed without waiting for his turn, as is often the case when applying to the wards of other institutions.

There are many private patients who become so impoverished after undergoing treatment for cancer, that, after a time, they are unable to continue, when its need is most urgent. For these patients, the Cancer Hospital may be the only asylum—truly the only place where they can continue their treatment and maintain their hope for eventual recovery or improvement.

On admission, each patient goes through a routine, common in all recognized hospitals. Before beginning the study of the patients, a necessary segregation is accomplished. The bed-ridden patients are left on the ground floor, while those who are in fairly good general condition and ambulatory are assigned to the upper wards. A complete history and physical examination is done in each case, followed by a complete blood count, urinalysis, and Wassermann test. Special clinical laboratory study is carried out on each case as indicated, such as gastric analysis and examination of feces for occult blood, together with a complete x-ray series of the gastro-intestinal tract, in cases in which malignancy of the stomach is found or suspected. X-rays of the chest and skeleton are taken on every patient suffering from cancer of the breast, whether or not such

¹ Read before the Annual Conference, Division of Cancer, Department of Hospitals, City of New York, April 10, 1937.

patients show evidence of general metastases. Pyelography is done on patients presenting themselves with signs of pathology in the genito-urinary tract. No operative procedure is undertaken on such patients without the kind of clinical and laboratory study just outlined. Any other blood or chemical study is carried out according to recognized rules and special indications.

Special preliminary care for each patient is decided upon and carried out as soon as feasible after admission. Patients suffering from oral malignancy are given a soft food and liquid diet, and frequent mouth irrigations and dental care whenever required. Those presenting large surface lesions, sloughing and secondarily infected, are cleansed as often as required with antiseptic solutions, and dressed. We have often found, after prolonged antiseptic care, that these lesions not only become less malodorous and less obnoxious both to the patients and those who attend them, but sometimes, after the complicating secondary infection is cleared up, lesions that at first appeared hopeless and beyond any kind of therapy, became operable, or at least suitable for radium or x-ray therapy. Some results obtained in such patients go beyond any expectations that we may entertain.

Let me cite a case. In the Fall of 1933, a colored female patient was admitted to the hospital, with an ulcerative cauliflower mass involving the upper outer quadrant of the right breast. In the inner lower quadrant of the same breast, a tense, diffuse, somewhat fluctuant mass was felt.

On the operating table a needle was inserted in the latter mass and pus aspirated. Subsequently this mass was widely incised and drained, while at the same sitting platinum needles of radon were inserted into the cauliflower mass in the upper quadrant of the breast. Two weeks later, the infection cleared up and the malignant lesion showed considerable shrinkage. A local mastectomy was then performed. The wound healed by primary union, and the patient was discharged home. To date,

she remains in excellent physical condition and shows no signs of local recurrence or metastasis.

Patients suffering from gastro-intestinal malignancy receive appropriate dietary treatment and bowel hygiene. Far advanced cases of ovarian carcinoma, in which surgery can no longer be employed, are tapped, if ascites is present, and thus obtain temporary relief. Far advanced cases of carcinoma of the cervix or uterus receive douches daily or oftener, and when this form of vaginal hygiene is persisted in, we occasionally achieve sufficient improvement to permit us to apply radium locally, in this manner stopping active bleeding, and for a time arresting the disease locally.

In this connection, let me cite another case. In September, 1934, we were asked to see in consultation a female patient at the City Hospital. On examination, we found an extensive neoplastic destruction of the cervix, with secondary infection and purulent discharge. The adnexa appeared so involved that we did not feel, for the moment, very sanguine about the result to be expected from radiation therapy. In addition, the patient was extremely anemic due to loss of blood. However, we advised transfer of the patient to the Cancer Hospital, where she was to receive vaginal hygiene, and a transfusion. Shortly thereafter, radium was applied to the cervix for a dose of 3,000 mc-hr. Three weeks later, a tandem was inserted into the cervical and uterine canal for 4,000 mc-hr, followed by a course of high voltage over the pelvis. When examined one month later, the cervix was normal in contour and consistency, without any sign of activity or recurrence. There was still slight induration in the right adnexa, but no nodular deposits. The general condition of the patient was good, and she was allowed to go home.

The type of cases housed in the Cancer Hospital is particularly prone to diseases associated with old age and debility, such as pneumonia and heart disease. Kidney affections are often the direct result of such conditions as cancer of the cervix with ad-

nexal metastasis causing pressure on the ureters. When such complications arise, they are treated scientifically by the house staff under the guidance of the visiting medical staff and genito-urinary staff. These cases are treated as medical or genito-urinary cases, irrespective of, though not ignoring, the malignant condition for which they entered the hospital.

When the cases have been worked up completely, they are finally presented to the Director and the visiting surgical and medical staffs for final decision regarding the specific kinds of treatment each is to receive. In cases in which surgery is advised, the patient receives special pre-operative care, such as transfusion, clyses, etc. Radium or x-ray therapy is carried out according to the Director's instructions. Later, after treatment, the patients are again presented so that the result and effectiveness of each type of treatment may be checked and evaluated. I shall not dwell here on the general results obtained from x-ray and radium therapy, but it may be in order to mention that patients, suffering excruciating pain as a result of generalized metastasis and requiring the use of narcotics when admitted, often are sufficiently relieved as not to require these drugs further, or in considerably smaller doses. Occasionally, too, patients with diffuse skeletal involvement and bed-ridden are able to get about for some time after receiving intensive radiation to the involved parts.

While I do not wish to convey the impression that our work at the Cancer Hospital is always, or even generally, crowned with the degree of success exemplified by the two patients I previously cited, it is nevertheless true that such successful results have been obtained in a goodly number of cases. When one bears in mind that cases transferred to us are usually of the more advanced type, regarded elsewhere as hopeless, our satisfaction in the remarkably good results we often obtain may be easily understood. To be able to arrest active malignancy in a custodial hospital, despite warranted expectations

to the contrary, and to be able to send the patient home in good health even temporarily, is most encouraging to all of us engaged in the care and treatment of these patients.

To sum up, the care of custodial patients, as outlined, results, in many instances, in great benefit to the patients themselves, who are transformed from a state of hopelessness and invalidism to a state of health, enjoying many of the comforts of life, with self-reliance and self-support, instead of continuing as a family or public charge. Yet, one must face the fact that only too many of our patients come to us too late, and in a terminal state, to get anything more than temporary alleviation of their extreme suffering.

A custodial hospital for cancer patients affords a field for clinical study of that disease which cannot be obtained at a general hospital, where the pressure of time and attention required by other patients makes such concentrated study difficult, if not impossible. The Cancer Hospital turns out about half a dozen young physicians yearly, specially trained in the treatment of cancer patients. This is of utmost importance to the future dealing with the cancer problem. These young men are trained not only in the bedside care of such patients, but become adept, in the course of their internship, in the performance of such operations as gastrotomy, colostomy, and tracheotomy—life-prolonging and comfort-producing operations. These measures are as important in cancer surgery as appendectomy, herniotomy, and cholecystectomy in general surgery. In addition, attempts are made to alleviate pain and discomfort by the various forms of nerve block—sacral, spinal, and peripheral—and by the use of new drugs and sera. All these measures are carried out under the direction and guidance of the Director and the visiting staff.

From the scientific viewpoint the greatest value afforded by a hospital of this kind is in the field of pathologic study. Last year, 175 autopsies were performed. Some

of the findings observed on the autopsy table were indeed revealing, giving a deeper insight into the course, development, and results in the various types of malignancy, thus influencing us in our ideas regarding the therapy of cancer itself

It will not be amiss to remark that whatever good results we obtain in our work at the custodial hospital are to a large degree due to the direct guidance we receive from our Director, his constant encouragement of our efforts and his confidence in our work when it is carried out conscientiously and with due diligence

Finally, it is hard for me to picture what would happen to many of the unfortunate cancer patients if the city did not provide that haven for them on Welfare Island. Without means for obtaining necessary treatment, they would indeed be hopeless and forlorn. But, provided with a hospital on Welfare Island, many of them pass their remaining days under proper medical care, and many others are reclaimed to a life of relative comfort and freedom from disease for a longer or shorter period of time, as a result of proper custodial care received at the Cancer Hospital

SOME LAWSUITS I HAVE MET AND SOME OF THE LESSONS TO BE LEARNED FROM THEM

(First Installment)

By I S TROSTLER, M D , F A C R , F A C P , *Chicago*

PHYSICIANS have long been preyed upon by the legal profession and it is admitted, yes, even sworn to (and at), that if it were not for the more or less constant attitude of aggressive hostility of a considerable number of the legal profession, to physicians (except when they are ill and find themselves unwillingly under our care), our path of duty, while perhaps not exactly like the proverbial bed of roses, would be much more conducive to mental ease and freedom from perplexity and restraint

While I make no pretension to any great knowledge of biblical lore, I do not believe that it will be at all amiss at this time to quote what a celebrated physician¹ of 1900 years ago said to the lawyers

"Then answered one of the lawyers, and said unto him, Master, thus saying thou reproachest us also

"And He said, Woe unto you also, ye lawyers! for ye lade men with burdens grievous to be borne, and ye yourselves touch not the burdens with one of your fingers

"Woe unto you! for ye build the sepulchres of the prophets, and your fathers killed them

"Truly ye bear witness that ye allow the deeds of your fathers, for they indeed killed and ye build their sepulchres

"Therefore also said the wisdom of God, I will send them prophets and apostles, and some of them they shall slay and persecute

That the blood of all the prophets, which was shed from the foundation of the world, may be required of this generation

From the blood of Abel unto the blood of Zacharias, which perished between the altar and the temple, verily I say unto you, It shall be required of this generation

"Woe unto you, lawyers! for ye have taken away the key of knowledge, ye entered not in yourselves, and them that were entering in ye hindered "

With that much of the Scriptures before us, let us take up our discourse

During the last thirty years the writer has appeared as a witness in quite a considerable number of legal proceedings. These suits at law have been of quite a variety, involving murder, suicide, rape, assault with intent to kill, assault with a deadly weapon, personal injury, accident insurance, and last but by no means least in interest or importance, medical malpractice. By far the greater number of the last-named suits were because of roentgen-ray injuries, real and alleged

In all except one of the medical malpractice cases, the writer has appeared or advised for the defense and he has the satisfaction of having helped to defend physicians either as a witness or in a consulting capacity in over one hundred of these cases, and in thirty-one different States and two Canadian Provinces

In relating the particulars of some of these suits, no effort will be made to keep up a sequence of events or to group the cases either geographically or in kind. Before beginning a recital of the cases, it may be well to cite a celebrated authority, as to what makes the law, and as to how and why adjudications of these lawsuits are made

As to "What makes the law," the late Oliver Wendell Holmes, Justice of the United States Supreme Court, said, "The life of the law has not been logic, it has been experience. It felt the necessities of the time, the prevalent moral and political theories, institutions of public policy, avowed or unconscious, even the preju-

¹ St. Luke 11:45-52

dices which judges share with their fellow-men have a good deal more to do than the syllogism in determining the rules by which men should be governed

"The law embodies the story of the Nation's development through many centuries, and it cannot be dealt with as if it contained only the axioms and corollaries of a book of mathematics "

As regards to how and why adjudications of cases are made, Morgan² says "The materials which the court will first examine in its search for the rule to be applied, are prior decisions If it finds an applicable precedent, it will ordinarily determine the controversy accordingly, if it finds no previous adjudication on all fours with the case in hand, it will try to ascertain whether any available decision has sufficient elements in common with it to require or justify an application of the rule used therein If it finds a precedent squarely in point or applicable by analogy but determines nevertheless that it ought not to be followed, or if it finds no pertinent precedent, it ought to and generally will, decide the case as it believes a proper condition of history, custom, morals, and sound public policy require Obviously in this process it does and must not only resort to judicial decisions of non-common law courts, but also (*sic*) non-legal materials It gives due weight, insofar as it is able to, to the known truths of all sciences affecting human experience and human conduct The resort to non-legal materials is not confined to the solution of common law problems, it is made, though perhaps to a less degree, in the interpretation and application of statutes "

WHAT CONSTITUTES MEDICAL MALPRACTICE?

A New York City physician, who was being sued for malpractice, asked me to cite to him a few points regarding "What is necessary in order to prove malpractice?"

I wrote, "In *Clayton vs English* (55 App D C, 324, 23 Fed R (2nd), 745, 56 Wash L R, 6), the Appellate Court of the

District of Columbia said that it is the duty of a physician in undertaking to treat a patient, to exercise the ordinary care and skill of his profession, *giving due consideration to modern advancement and learning*, and that there is an implied agreement that no injurious consequences will result from want of such proper skill, care, and diligence, that one who seeks to recover against a physician, alleging lack of skill or negligence, has the burden of proving his averments

"In the *Clayton case (supra)* we quote from the opinion of Judge Taft, now Chief Justice of the United States Supreme Court, in a malpractice case (*Ewing vs Goode*, 78 Fed R, 442), in which he said, 'Before the plaintiff can recover she must show by affirmative evidence—first, that defendant was unskillful or negligent, and second, that his want of skill or care caused injury to the plaintiff If either element is lacking in her proof, she has presented no case for the consideration of the jury The naked facts that defendant performed operations upon her eye and that pain followed, and that subsequently the eye was in such bad condition that it had to be extracted, established neither the neglect or unskillfulness of the treatment, nor the casual connection between it and the unfortunate event '

"A New York case, very much to the point and particularly interesting to you at this time, is *Grimaldi vs Zeglio* (129 Atl R, 475) Here the court said, 'A case of malpractice cannot be proven by the testimony of a few physicians or surgeons that they would have used some other treatment than the one used, in the absence of testimony, from which it can be inferred that the defendant failed to give the case that skill and care ordinarily possessed and exercised by others in the profession '

"The case of *Hazen vs Mullen* in Washington Law Reporter of April 26, 1929, may also shed some helpful light upon the subject to which you refer Here the Court of Appeals of the District of Columbia reversed a judgment of the District Supreme Court, which had been rendered against Dr Hazen in a roentgen dermatitis case

² Morgan The Study of Law Chapter II The Nature and Source of Law page 29

"If you look up *Williams vs Poppleton* (3 Ore R , 193, *MacKenzie vs Carman* (103 App Div 246, 92 N Y Supp , 1063) you may find additional and desirable information for use by your attorneys Good luck to you "

A BAD MALPRACTICE CASE

About seventeen years ago, a radiologist in eastern Ohio called over the long distance telephone and told me that a younger brother of his was suing a gynecologist in central Ohio for malpractice, because of improper treatment of a fracture of the femur

My confrère said that he was sending the plaintiff (his brother) to me, to arrange for me to give expert testimony for him, and that I was to secure a surgical expert witness as well I demurred somewhat and told him that I was very much averse to appearing against a physician in a malpractice suit, but was assured that the case involved such gross and atrocious malpractice that any scruples I might have in that regard, would be swept aside when I heard about and examined into the particulars of the case

The brother came to Chicago, and upon hearing about the case I learned that there had been a simple transverse fracture near the middle of the left femur, which had been treated by splinting, without any extension and that no roentgen examination had been made until eight (8) weeks after the injury This occurred in a city of over 200,000 population, with plenty of opportunities for everything necessary for proper treatment of the patient

Roentgen examination disclosed union of the fractured halves, side by side, with five and one-half ($5\frac{1}{2}$) inches over-riding and, of course, shortening of the thigh to the same extent

I called a surgeon to see the patient and took the case under advisement The surgeon and I decided to leave it to the presidents of the Chicago Medical and Illinois State Medical Societies, as to whether we should testify for this grievously wronged patient Both of these high society officials

said that we should testify, because, by so doing, we would render a beneficial and helpful act for medicine and the public welfare

We appeared at the trial and gave our testimony There was no other medical testimony, as it was recognized to be such gross and absolutely inexcusable negligence that the physician defendant in the suit was unable to secure any one to rebut the testimony of the plaintiff's witnesses—even though there were about six hundred physicians in his home town, where this suit was tried

The jury rendered a verdict in favor of the plaintiff, giving him \$9,000 damages, which was promptly paid

The foregoing is the only instance in which the writer ever appeared as a witness against a physician defendant, and, as before stated, it was done with the consent and advice of the presidents of both State and local medical societies

A WISCONSIN (X-RAY) MALPRACTICE SUIT

In 1921 I was visited by a Wisconsin physician and his attorney, and consulted relative to aiding in the defense of a malpractice suit which alleged injury in the form of a roentgen dermatitis

The plaintiff, a cable splicer, had had a rather troublesome eczema on his back and had applied to the physician defendant for relief The doctor applied a moderate roentgen treatment to the involved area and directed the patient to return for observation, but before the date set for his return to the physician, he was sent to another location and while there (in a larger city) he consulted another physician regarding his eczema The latter physician prescribed an ointment which the patient applied with rather disastrous results, in that a considerable area on his back broke down and when it did heal, left a scar several square inches in extent

A few months later, the patient was taken in hand by a lawyer and a malpractice suit was started against the physician who had applied the roentgen therapy At

dices which judges share with their fellow-men have a good deal more to do than the syllogism in determining the rules by which men should be governed

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roentgenologist, who, if he were to testify to-day, under exactly similar conditions, would not say anything like what he said that day in Peoria

"There are numerous decisions from some of the best and most highly respected and closely followed Supreme Courts in this country, which specifically and in so many words state that the doctrine of *Res ipsa loquitur* does not apply in medical malpractice suits. I call your attention to *Street vs Hodgson*, 115 Atl R, 27, *Evans vs Clapp et al*, 231 S W R, 79, *Stemons vs Turner*, 117 Atl R, 922 (all x-ray cases) and others that could be mentioned. These cases are multiplying, and rightly and justly should multiply, as the public is getting so that any physician, no matter how careful and skillful, is likely to have his reputation blasted sky-high by an unjustifiable malpractice suit.

"I take it that you are asking this information for the purpose of helping the defendant in the case,³ as I feel sure that you think too much of your standing in the various societies to even consider appearing against any regular physician in a malpractice suit. We cannot be too careful about this, as we do not know how soon we may have to have similar aid from our fellows.

"I have had numerous opportunities to appear as witness against other physicians, being offered large fees to do it, but have refused because of reasons too numerous to mention. I have no doubt that many other men of reputation and standing have had the same experience.

"On the other hand, I know of several fairly good men who have appeared as witnesses against reputable physicians, who have lost caste and standing, just because they did this, either for the considerable fee that they received, because of spite against the other fellow or for other minor reasons. There is no question that physicians would have a great many less malpractice suits filed and practically none decided against

them, if their colleagues and competitors would refuse to testify against them. None of us is perfect and we cannot know when some slight slip or miscalculation might make a difference in things so as to make us appear to have been negligent or wrong in the eyes of the malpractice lawyer.

"They—the lawyers—do not respect us when we help them fight against one of our own kind, and in fact we actually lower ourselves in their esteem by being willing to help prosecute such cases. I know, because I have a number of friends among the legal profession, and all of them tell me this. Our profession is so well known for this very thing, that we are at times actually scoffed at by the legal profession for it."

It is scarcely necessary to say that that bright young radiologist, to whom the foregoing letter was written, did not testify in the suit mentioned. In the absence of any medical witness testifying that the defendant physician was negligent, the trial judge directed the jury to bring in a verdict in favor of the physician defendant.

TWO PENNSYLVANIA CASES

Several years ago, a young physician in western Pennsylvania, while attempting the removal of a fragment of metal from the foot of a patient, used the fluoroscopic equipment (consisting of an open tube stand and a hand cryptoscope) belonging to a dentist, the dentist operating the x-ray apparatus and the physician using the hand fluoroscope.

Evidently, while searching for the foreign body, they approached the unguarded tube too closely or they applied the x-rays for too long a time, or both, because the patient later developed a third degree roentgen dermatitis, with considerable sloughing, endarteritis, and ulceration, which necessitated the amputation of the foot above the ankle joint. The patient sued the dentist for malpractice.

During the fluoroscopy, the physician's hands were also severely injured by the excessive radiation, and he also brought suit against the dentist.

³ I was almost sure that he was not doing that but deemed it good policy to lead him to think that way—sort of a diplomatic white lie.

the time I was visited, both the physician defendant and his attorney were wringing their hands in terror and grief at the prospect. The suit was for a neat sum and they were about ready to offer a settlement, but when I heard the story and the amount of x-rays applied, I felt sure that the injury, if any existed, was due to the application of the ointment prescribed by the second physician, rather than to the x-rays alone.

In due time I was called to attend the trial and after going on the stand and testifying that x-radiation was good treatment for chronic eczema, that the dosage applied was not excessive and would not produce an injury, the court allowed the parties in the suit to agree that I examine the injured area on the plaintiff's back.

In the Judge's chambers, alone with the plaintiff while examining him, I asked him if he had not seen another doctor, who had given him a salve for his back. He promptly said, "Why, yes," and upon my query as to what kind of salve it was, he took a prescription from his pocket and showed it to me. That prescription contained a high percentage of salicylic acid in a resorcin ointment. I handed the prescription back to the plaintiff and advised the defendant's attorney to call the plaintiff to the witness stand that afternoon and get him to produce the prescription and to have that prescription written into the records of the case. This was done, with considerable difficulty, and over the repeated objections of plaintiff's attorneys.

After that was done, I was recalled to the witness stand and caused to describe what the effect of the salicylic acid ointment in the prescription would be on ordinary, normal skin after the application of the amount of x-rays used by the defendant.

Evidently my testimony was so convincing that the jury returned a verdict for the defendant, with a judgment in full for the amount of the defendant physician's fee.

The case was appealed to the Wisconsin Supreme Court, where the verdict of the trial court was affirmed. The written decision of the Supreme Court stated that the

evidence of the expert witness from Chicago was not denied or controverted, and upon that itself, the verdict was a just one.

HE DID NOT TESTIFY

Just about ten years ago, word reached me that a bright, keen young radiologist in central Illinois was about to arrange to testify against one of his competitors, in a roentgen dermatitis malpractice suit.

Strangely and opportunely, I received a letter from this same young man, by the next mail. The letter read in part "I expect to be called into court in the near future concerning a case of radiodermatitis which occurred following the attempted removal of a needle, under fluoroscopic control. The examination occurred in another institution with which I am not connected (*sic*) and I did not see the patient until some six weeks later.

"Knowing that you are familiar with all the phases of this problem, I am writing you at this time to ask particularly whether the Illinois Courts consider an 'x-ray burn' to be *prima facie* evidence of negligence. Possibly you could refer me to some cases which would help clarify the situation."

This letter, of course, gave me exactly the opening and opportunity I wanted, and by return mail I replied "Yours of the 28th to hand and noted. In reply will say that I know a little about the suit you mention and have reason to believe that the decision will be in favor of the defendant. At least I hope it will be, and the wish is father to the hope in this instance. My belief is based upon several things that have come up heretofore in similar cases.

"In regard to the doctrine of *Res ipsa loquitur* (the thing speaks for itself), applying in Illinois, will say that the only case in this State where that doctrine has held good in the Supreme Court, is the Peoria case (*Holcomb vs. Hannah and Magee*, 217 Ill. R.). Here it is specifically stated that the production of an x-ray dermatitis, resulting during a diagnostic procedure, is evidence of negligence. That decision is based upon the testimony of a Chicago

roentgenologist, who, if he were to testify to-day, under exactly similar conditions, would not say anything like what he said that day in Peoria

"There are numerous decisions from some of the best and most highly respected and closely followed Supreme Courts in this country, which specifically and in so many words state that the doctrine of *Res ipsa loquitur* does not apply in medical malpractice suits. I call your attention to *Street vs Hodgson*, 115 Atl R, 27, *Evans vs Clapp et al*, 231 S W R, 79, *Stemons vs Turner*, 117 Atl R, 922 (all x-ray cases) and others that could be mentioned. These cases are multiplying, and rightly and justly should multiply, as the public is getting so that any physician, no matter how careful and skillful, is likely to have his reputation blasted sky-high by an unjustifiable malpractice suit.

"I take it that you are asking this information for the purpose of helping the defendant in the case,³ as I feel sure that you think too much of your standing in the various societies to even consider appearing against any regular physician in a malpractice suit. We cannot be too careful about this, as we do not know how soon we may have to have similar aid from our fellows.

"I have had numerous opportunities to appear as witness against other physicians, being offered large fees to do it, but have refused because of reasons too numerous to mention. I have no doubt that many other men of reputation and standing have had the same experience.

"On the other hand, I know of several fairly good men who have appeared as witnesses against reputable physicians, who have lost caste and standing, just because they did this, either for the considerable fee that they received, because of spite against the other fellow or for other minor reasons. There is no question that physicians would have a great many less malpractice suits filed and practically none decided against

them, if their colleagues and competitors would refuse to testify against them. None of us is perfect and we cannot know when some slight slip or miscalculation might make a difference in things so as to make us appear to have been negligent or wrong in the eyes of the malpractice lawyer.

"They—the lawyers—do not respect us when we help them fight against one of our own kind, and in fact we actually lower ourselves in their esteem by being willing to help prosecute such cases. I know, because I have a number of friends among the legal profession, and all of them tell me this. Our profession is so well known for this very thing, that we are at times actually scoffed at by the legal profession for it."

It is scarcely necessary to say that that bright young radiologist, to whom the foregoing letter was written, did not testify in the suit mentioned. In the absence of any medical witness testifying that the defendant physician was negligent, the trial judge directed the jury to bring in a verdict in favor of the physician defendant.

TWO PENNSYLVANIA CASES

Several years ago, a young physician in western Pennsylvania, while attempting the removal of a fragment of metal from the foot of a patient, used the fluoroscopic equipment (consisting of an open tube stand and a hand cryptoscope) belonging to a dentist, the dentist operating the x-ray apparatus and the physician using the hand fluoroscope.

Evidently, while searching for the foreign body, they approached the unguarded tube too closely or they applied the x-rays for too long a time, or both, because the patient later developed a third degree roentgen dermatitis, with considerable sloughing, endarteritis, and ulceration, which necessitated the amputation of the foot above the ankle joint. The patient sued the dentist for malpractice.

During the fluoroscopy, the physician's hands were also severely injured by the excessive radiation, and he also brought suit against the dentist.

³ I was almost sure that he was not doing that but deemed it good policy to lead him to think that way—sort of a diplomatic white lie.

At the time of the trial of these two suits, the writer was sent for and testified that the amount of irradiation claimed to have been used (by the dentist), *viz*, 8 ma, 5 inch S G, 24 inches F S D, unfiltered for 4 minutes, would not produce injury, and that he would not hesitate to apply four times that amount. But both of the plaintiffs claimed that the time was much longer and the F S D was less (and they were probably correct).

The case of the patient who lost his foot was tried and a verdict with liberal damages was given to the plaintiff. This was later settled for a reasonable sum.

The suit of the young physician, whose hands were considerably damaged, was settled, at my advice.

Cases such as these are altogether too numerous and should be a lesson to physicians who insist upon the extended use of fluoroscopy, but who refuse to heed the warnings and advice of the man at the switch.

A time switch in the circuit is the best protection against this eventuation.

WERE THE FILTERS IN PLACE?

(I hae me doots)

About ten years ago, the attorney for an insurance company asked me to investigate into the merits and liability involved in two suits filed against an Illinois radiologist, and to report upon and advise as to the best defense regarding them.

The patient was suing for damages, alleging malpractice, negligence, and carelessness and gave the usual long list of complaints, because of a dermatitis in several places on her body and limbs, resulting from the application of the roentgen rays.

At the same time, her husband was suing the doctor for loss of companionship, damages to himself because of the alleged injury to his wife, expense incurred, etc.

The history of the defendant physician's contact with the woman plaintiff was as follows: Mrs S Z, aged 40, entered N T Hospital three years ago with a diagnosis of sciatica by Dr J T. No roentgen examinations were made at that time. She

left the hospital three days later. Two days later defendant physician (Dr N J L) administered "high frequency" current over back and right thigh for five minutes. During the next six weeks he administered six more such treatments, the time of the last one being twenty minutes. At no time during this course of high frequency therapy was there any erythema or redness produced.

On Aug 4, 1923 (a little more than a year later), this same patient was referred to the radiologist—by the same family physician—for x-ray treatment for spleno myelogenous leukemia. The following x-ray therapy was administered by defendant, at his private offices: Aug 4, 1923, 3 ma, 3 min, 8 inch S G, 10 inches F S D, 3 mm Al filter, over four areas on anterior aspect of abdomen and thorax; Aug 7, 1923, same technic to back of thorax and abdomen and one area anteriorly over spleen; Aug 10, 1923, same technic, four areas over upper portion of back; Aug 18, 1923, same technic, four areas over entire back; Aug 21, 1923, same technic, anterior portion of thorax and one anterior over spleen; Aug 25, 1923, same technic, four areas over entire back and four areas over legs.

About three weeks after the first treatment Dr J T (the referring physician) reported definite improvement in the blood picture and reduction in the size of the spleen.

About Sept 1, 1923, an area of redness was noticed in the hypogastric region about 8 x 10 inches in size, *sharply demarcated*, and other areas on the dorsum of both feet and on the anterior aspect of the right thigh. Patient complained of pain. She was still complaining of her sciatica. The redness continued and was followed by blistering in the forementioned areas, and what appeared to be a second degree radiodermatitis appeared.

The patient entered the hospital for the dermatitis on Sept 20, 1923, and left it on Oct 24, 1923. The records of the hospital state that a diagnosis of x-ray burn was made, and that "the burned areas had all

healed and patient was in excellent condition "

On Nov 10, 1923, Dr L (defendant) administered ultra-violet from a mercury vapor air-cooled lamp for one minute (*sic*) at his office

Defendant next saw plaintiff in May, 1924 (six months later), after she had been operated upon by Dr B E C at the Presbyterian Hospital, where an area on the dorsum of one foot had been dissected off and skin grafts implanted thereon. At this time she had an unhealed area about the size of a quarter-dollar on the middle of the dorsum of one foot. About the latter part of December, 1924, two and one-third years after the last treatment (*sic*), the skin on the dorsum of the other foot broke down.

The foregoing history was given to me by the defendant and when it was transcribed for me, I noticed the several contradictions and incongruities.

My report to the insurance company was as follows:

"In pursuance to the request of your attorney Mr F X S, I have gone over the above-named case, listened to the statement of the defendant, read the information blank as furnished by the defendant to you under date of , the plaintiff's declaration, and have gathered such additional information as I could from other sources. Having weighed all of the foregoing, I will give you my opinion of the case.

"It is within the range of the experience of the most competent and best qualified physicians who have been using the x-rays for many years in therapy, that x-ray dermatitis occurs under the most minute and painstaking care, and the so-called 'delayed reactions' of the type which the plaintiff in this case is alleged to have had on her feet, are not at all rare.

"Authorities on radiotherapy are agreed that patients are occasionally met with who are peculiarly susceptible to the effect of the x-rays. This effect may be an idiosyncrasy in which the x-rays have either a very much lessened effect than under nor-

mal conditions, or the person in question may be extremely hypersensitive to the effect of the x-rays, with the result that dosage of the x-rays which would be normal and physiological in the ordinary average patient, would produce a dermatitis or so-called x-ray burn in the first, second or even third degree, when applied to them. It is also recognized by authorities in radiotherapy that there is no way of determining the presence of this idiosyncrasy, and that the only safe method of procedure is to try the tolerance of the patient by moderate dosage when there is any question or doubt. Of course, I do not mean to say that we are not able to determine the dosage in the average case. We know that dark-skinned, dark-haired people tolerate the x-rays much better than do the pale-skinned, light-haired, blonde people, but it has been the experience of all who have done any great amount of x-ray work that these rules have their occasional if not frequent exceptions.

"In the case under discussion the records of the treatment are *not* such as would lead anyone to believe that they are careful, authentic and made at the time of the administration of the treatment. The technic given me by the defendant specifies that he administered x-ray treatment to 16 areas on the back of the patient (plaintiff), and 10 areas on the anterior surface of the patient. The dates given by him (to me) extend from Aug 4 to Aug 25, 1923. He read these from a card when he visited my office Jan 22, 1925. In his report to you under date of March 3, 1924, he mentioned the same dates as those he gave to me, but added Sept 4, 1923. While these discrepancies are in themselves of minor importance, they none-the-less show that the dates and data are not accurate and consequently unreliable.

"The fact that all the injuries complained of (and observed by the defendant) occurred on the anterior aspect of the patient's body and extremities, whereas the defendant, according to his data, administered more than one and one-half times as much treatment (or sixteen-twenty-sixths

of all the treatment according to my information) *on the back* of the plaintiff, is to me almost conclusive evidence that the filters were left out in the areas receiving the injuries. These injured areas were, according to description given to me by the defendant, an area 8×10 inches in size, *sharply demarcated* on the hypogastric region, an area on the anterior aspect of the right thigh, and areas on the dorsum of both feet—the latter areas having later to be operated on and skin grafted.

"Now then, if idiosyncrasy or hypersensitiveness entered into the elements of this case, surely the patient would have received the injuries on the back instead of on her abdomen and anterior surface of her right thigh, etc., because of her having received sixteen-twenty-sixths of her treatment on her back, and although defendant asserts in the strongest terms that he did not leave out the filters in any instance, I can see no other reason for the production of the injuries. Understand me, I do not in any way want to impugn the honesty or sincerity of the defendant in this case, but he must be mistaken.

"Of course the possibility or probability of the application of some caustic or escharotic drug in the form of an ointment or lotion (as in the case of *Rost vs Roberts* at Portage, Wis., which you may remember I brought out), is to be considered, but the fact that in this case, the one under consideration, the injured areas showed sharp demarcation, which would tend to point away from the likelihood of this—the application of drugs—even contributing to the production of the injuries, and would consequently lessen the force or benefit of any such defense, because no ointment or lotion would be applied in such straight lines as characterize the descriptions of the injured areas.

"While I do not hesitate to say that we could produce almost any number of witnesses who could qualify as experts to the limit, who would testify that the dosage of x-rays administered *according to the records* was *not excessive*, and should not produce injury to the skin or underlying tissues, I

am equally sure that, if these same witnesses would be asked for an opinion as to why the injuries did occur, every one of them would say that omission of the filter in the areas where the injuries occurred was the most likely cause, and as omission of the filter in this class of x-ray therapy is inexcusable negligence, in the absence of any other good cause for the production of the injury, I must say that I am at a loss to suggest any good line of defense.

"While I am, as you well know, in every way very much against the practice of settling any malpractice suit, because of the reasons above set forth, I feel inclined to advise that these cases be settled, but if settlement cannot be satisfactorily effected, I will be glad to confer with you or your attorneys if desired, and to help in any way within my ability."

Both of these suits were settled.

The insurance company in acknowledging my report, said "The theories and facts which you have outlined to us will be helpful not only in securing a disposition or defense in the above cases, but will be valuable also in preparing the defense of other x-ray burn cases. This type of case is indeed difficult to handle from a defensive standpoint and your assistance in determining the merits of these cases is appreciated."

BETWEEN THE PARIETAL BONE AND THE OS CALCIS

About twenty years ago I was in one of the superior courts of this county, as an expert witness in a personal injury case. I was called to testify by the defendant in the suit and, as is frequently done, the attorney for the plaintiff determined to try to discredit me and reduce the effect of my testimony upon the jury. He was a carefully dressed, dapper, suave, smooth-tongued, velvety-voiced individual, whom one much less experienced than I, could see, had a rather high opinion of himself.

After a brief but searching cross-examination of me, he asked me if it was not advisable that a physician specializing in radiology be a good anatomist. Suspecting

a trap, I casually answered in the affirmative. He then proceeded to question me in various and devious ways, about my knowledge of anatomy, whether I had taught anatomy and about my own opinion as to whether or not I considered myself to be a good anatomist, but not asking me any question in anatomy. I guardedly admitted that I had taught anatomy didactically, on the cadaver and on the living subject, and that I believed myself to be a good anatomist.

This sort of thing was continued for fifteen or twenty minutes, with yours truly shiftily sparring with words until the opposing attorneys objected to the great *waste of my time*, at the end of which he asked me if I could inform that intelligent

court and jury the anatomical location of the ganglion spirale. I answered that I could—still sparring for time—whereupon he said, "Now, Doctor, tell this court and jury the location of that ganglion." I immediately replied, "Between the parietal bone and the os calcis," which completely satisfied him that I was a good anatomist.

A physician friend, who was seated in the court room, hurriedly stuffed his handkerchief in his mouth and hastily left the room.

Twelve years later, a legal friend told this story at a little dinner in the Royal York Hotel at Toronto and the members of the group were much interested to learn that I was the anatomist who gave that answer.

(*To be continued*)

OBSERVATIONS ON RATS WITH A TRANSPLANTABLE FIBROSARCOMA TREATED WITH CEVITAMIC (ASCORBIC) ACID

By JOSEPH A POLLIA, M D , *Los Angeles*

Director of Research, Frank H Boyer Foundation

IN the laboratories of the Frank H Boyer Foundation, a transplantable rat fibrosarcoma has been developed from injections into the flanks of rats of 4 milligrams of Eastman Kodak Company's 1 2 5 6 dibenzanthracene in 1 c c of lard oil, as suggested by Hieger, Burrows, and Kennaway (1) This tumor, for the sake of convenience, has been called the Boyer fibrosarcoma No 1 It has passed through six generations, is highly malignant, since the animals with untreated tumors rarely live longer than one month, and in over 300 transplants only one has failed to "take " The tumor assumes an enormous size, often one-third by weight of the animal, is very hemorrhagic, and sloughs easily

Our rats are an inbred stock, derived from an original pair obtained four years ago They occupy outside quarters all the year 'round in wire cages which house four to eight animals The sexes are not segregated, and they are fed a standard powdered stock ration without any additions

At the suggestion of Mr Anthony J Lorenz, Director of Nutritional Research for the California Fruit Growers Exchange, two groups of our sarcomatous animals were fed and injected with cevitic acid, Merck's, on the basis that it might influence the tumor growth through its action upon the oxidation reduction process, as postulated by Szent-Gyorgyi in

his studies on the effect of vitamin C on the adrenal gland and adrenalin

Woodhouse (3) had reported that warts produced by painting tar on white mice became malignant more rapidly, and that the malignant process as a whole seemed accelerated, when 0.2 ml of 0.5 per cent of cevitic acid in saline was injected subcutaneously twice weekly, and Fodor and Kunos (4) reported the acceleration of growth of Ehrlich's mouse carcinoma when cevitic acid was administered

Our study was carried out on two groups of animals The first consisted of eight experimental and two control animals The supply of cevitic acid, however, was exhausted, and before an additional stock could be obtained some of the animals died and the remainder were either sacrificed or used for other work

Description of Experiment—Ten mg of cevitic acid tablets were pulverized and mixed in a 2 cm ball of raw ground beef for feeding The injections were made with 25 mg of the crystals in 2.5 ml of sterile distilled water prepared immediately before use The skin of one of the two animals sloughed at the point of inoculation after the first injection, therefore, injections were discontinued until later, when it was suggested by Fisher and Leake (5) that the solution be neutralized with bicarbonate of soda, one-half by weight of the contained acid, which apparently prevented further subcutaneous tissue damage

GROUP I—CEVITAMIC ADMINISTRATION

Animal	Start	Finish	Treatment	Results
Female No 3	11/16/34	12/24/34	Fed 10 mg daily for 8 days	Died
Female No 7	11/16/34	12/18/34	Fed 10 mg daily for 8 days	Tumor regressed
Male No 12	11/16/34	12/18/34	Fed 10 mg daily for 7 days 1 intraperitoneal	Sacrificed
Female No 8	11/16/34	12/18/34	1 intraperitoneal	Used in other exp
Male No 7	11/16/34	12/18/34	Fed 10 mg daily for 9 days and 25 mg intraperitoneally for 3 days	Used in other exp
Female No 9	11/16/34	12/27/34	Fed 10 mg daily for 8 days	Died
Female No 2	11/16/34	1/3/35	Fed 10 mg daily for 8 days	Sacrificed
Female No 11	11/16/34	1/3/35	Fed 10 mg daily for 8 days	Sacrificed

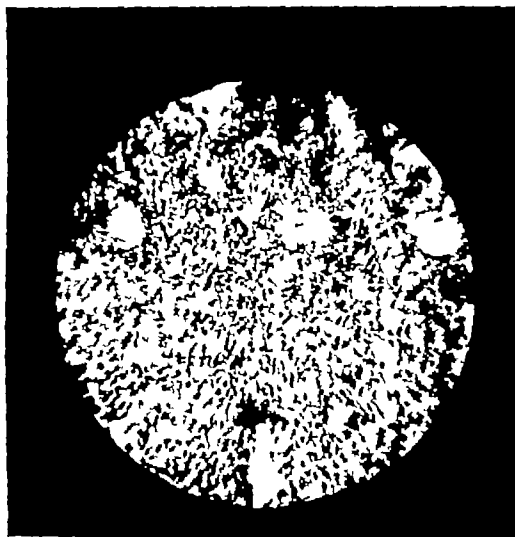


Fig 1 Boyer rat sarcoma Section through a vascular portion 100 X

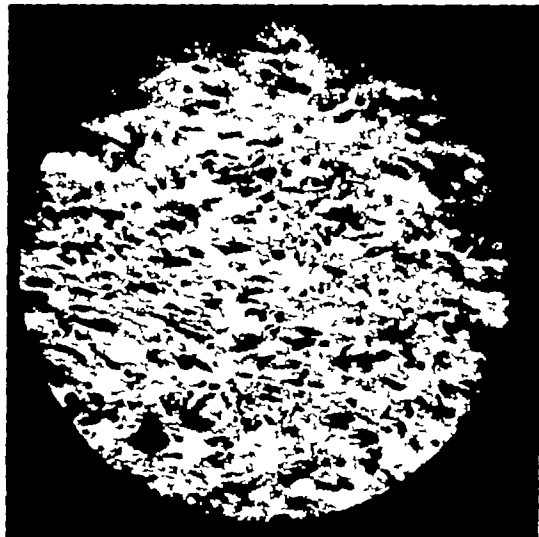


Fig 2 Boyer rat sarcoma Magnified 200 X

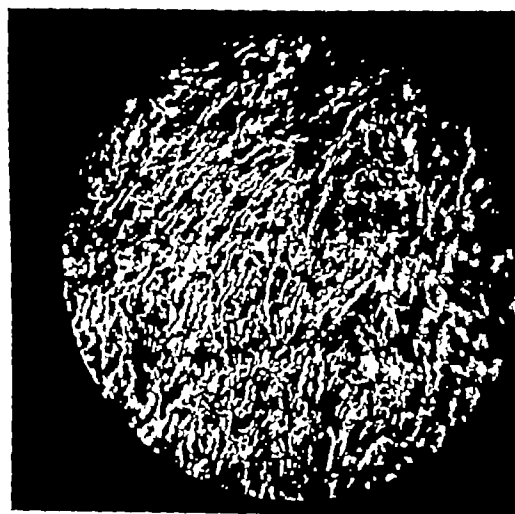


Fig 3 Boyer rat sarcoma Section through central portion This was the transplant in female No 27 200 X

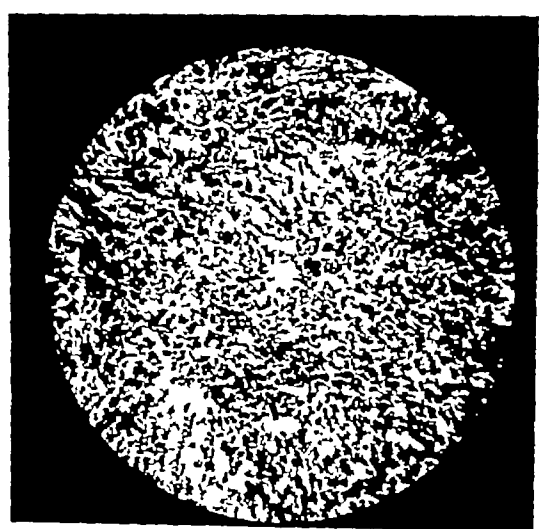


Fig 4 Intra abdominal tumor taken from female rat No 27 which developed during the injections of cevitic acid 200 X

FEEDING EXPERIENCES

Females No 2, 3, 7, 9, and 11 were fed 10 mg daily for 8 days Female No 8 and male No 12 received a single injection of the unneutralized acid Male No 12 developed the slough, after which these two animals were fed cevitic acid Male No 7 was first fed for 9 days and then was injected for 3 consecutive days with 25 mg of the acid The controls both succumbed on Dec 28, 1934 These observations revealed

no essential differences in the behavior of the tumor under the influence of material, except that in female No 7 the tumor regressed

EXPERIENCES WITH INJECTIONS OF CEVITAMIC ACID

Group II consisted of six animals, four experimental and two controls Each was injected intraperitoneally three times a week with 25 mg of cevitic acid neutralized with 12.5 mg of c p sodium

bicarbonate dissolved in 25 c.c. of distilled water. Measurements of the tumor were taken at the beginning and termination of the experiment. All animals had to be sacrificed, or were dead by the twenty-sixth day. Although the Boyer sarcoma No. 1 rarely infiltrates, the animals succumb to the exhaustion produced by carrying it, absorption of sloughing tissue products, and not infrequently of the anemia from the hemorrhage.

BLOOD COUNT ON ANIMALS IN GROUP II

	Female No 24 Control	Male No 17 Control	Female No 28	Female No 33
Hemoglobin	105%	85%	68%	50%
Erythrocytes	5 650 000	4 940 000	3 190 000	2,450 000
Color Index	0.88	0.88	1.06	1.20
Leukocytes	4,000	3 000	5 000	5 600
Polymorpho nuclears	45%	35%	59%	57%
Large Lym- phocytes	5	7	3	2
Small Lym- phocytes	45	50	29	35
Mononuclears	2	6	3	3
Basophiles	0	0	1	1
Eosinophiles	2	1	3	1
Transitionals	1	1	2	1
Endothelial				

Observations—Female No. 24 and male No. 17 were controls and had to be sacrificed. Male No. 7 died and was found mutilated. Females No. 28 and No. 33 carried bilateral transplants and showed a marked hyperchromic anemia. Female No. 27 presented a striking feature, she was found dead with the abdomen moderately distended by bloody fluid. Whitish-yellow neoplasms 2 × 2 mm. to 2 × 2 cm. studded the omentum and mesentery.

Several were implanted on the anterior wall of the stomach, and a few were floating freely in the peritoneal cavity. Frozen sections revealed a structure which suggests an endothelioma (Fig. 1). Blood count was not made on this animal. The sarcoma transplants behaved no differently in any of this group.

CONCLUSIONS

Fourteen rats, inoculated with a fibrosarcoma produced by 1,2,5,6-dibenzanthracene, were treated with oral and intraperitoneal administration of cevitic acid, and no marked difference was noted on the behavior of the tumors in the control and experimental animals, except for the regression of the tumor in one animal.

Two of four injected rats showed a hyperchromic anemia. One developed multiple intra-abdominal tumors which resembled an endothelioma, in addition to the fibrosarcoma from the transplant.

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GROUP II

Animal	Start	Finish	Measure Anterior	Tumor Posterior	Treatment	Remarks
Female No. 24	1/31/35-2/26/35		2.0 × 1.6	4.1 × 3.5	Control	No anemia
Male No. 17	1/31/35-2/26/35		1.4 × 1.0	3.6 × 3.0	Control	No anemia
Female No. 27	1/31/35-2/25/35		2.0 × 1.8	3.7 × 2.7	25 mg. cevitic acid injected	Multiple intra-abdominal tumors
Male No. 7	1/31/35-2/25/35		2.0 × 2.0	3.2 × 3.1	25 mg. cevitic acid injected	Died and found mutilated
Female No. 28	1/31/35-2/26/35		1.2 × 1.0 1.9 × 1.9	5.0 × 4.9	25 mg. cevitic acid injected	Marked hyperchromic anemia
Female No. 33	1/31/35-2/26/35		2.0 × 1.7 Left 1.2 × 1.1 Rt.	3.0 × 2.7 4.9 × 4.3	25 mg. cevitic acid injected 25 mg. cevitic acid injected	Marked hyperchromic anemia Marked hyperchromic anemia

OBSERVATIONS ON THE USE OF 800,000-VOLT ROENTGEN RAYS IN RADIATION THERAPY¹

By HENRY SCHMITZ, M D , F A C S , F A C R , *Chicago*

From the Department of Gynecology, Loyola University School of Medicine, and the Mercy Hospital Institute of Radiation Therapy

IN the beginning of 1933, an 800,000-volt peak transformer and a cascaded Coolidge tube, were added to the equipment of radium and 200,000 volt-transformers and oil-cooled, shockproof Coolidge tubes in the department of radiation therapy at the Mercy Hospital, Chicago. I take the liberty to record the observations made with the ultra-short wave roentgen ray in the treatment of malignant tumors. A thorough efficiency in the operation of the new installation was soon acquired, the greatest difficulty being in the operation of the two-section tube. However, a new and improved tube was installed about Sept 1, 1933. Since then, there has not occurred a single breakdown due to puncture or leakage, though the tube, at the present writing, has registered more than 2,000 hours at a 10-ma load. The transformer and cascaded tube with water-cooling and oil vacuum pumps are as easily operated as a 200,000-volt transformer and oil-cooled gas-free tubes.

The observations may be divided into those of a physical nature and biologic reactions, observed clinically in the tumors and in the patients. The physical factors should designate the quality of the radiation, the relative distribution of the radiation intensities in the tissues, and the quantity or radiation dose absorbed in the body. The biologic factors comprise the palliative effects—relief from pain, bleeding, and infection, the state of the blood, and the arrest in growth and resorption of the tumor tissue.

The radiation dose is the product of quality or intensity and the time duration of application. It may be expressed in a

biologic or physical magnitude. The former may be denoted as the erythema skin dose, the threshold skin dose of Failla and Quimby, or the tolerance skin dose of Schmitz. The ratio between these biologic doses is as 150 : 100 : 200. The physical unit of the radiation dose is the international r, which should be determined by standardized dose meters. In denoting the dose in either the biologic or physical measurements, the following factors should always be stated: the voltage or wave length, the half value layer, the type of current and transformer, the type of tube, whether water- or oil-cooled, or whether made of thin glass or pyrex glass walls, the filter, and its position within the radiation beam, the focus-skin distance, the size, location, and number of fields, the milli-ampere load, and the number of r applied to each field. Thus, one may be able to duplicate the technic either for experimental or therapeutic purposes. It is necessary also to describe the diameters of the body portion which contains the growth and the size of the growth, with its relation to the body surfaces on which the fields are placed. In this way the topographical relations are obtained which should facilitate the planning of a correct technic of treatment.

THE PHYSICAL FACTORS

The physical factors of special interest in 800 K V roentgen therapy are (1) the determination of the quality of radiation, (2) the distribution of absorption within the body volume, (3) the determination of the skin dose. Owing to the complicated nature of these phenomena, such determinations can at best be only approximations. They are useful, however, if the permissible error is within the region of practical therapeutic application.

¹ Read at the Annual Meeting of the California State Medical Society at Yosemite, California May 13-16, 1933.

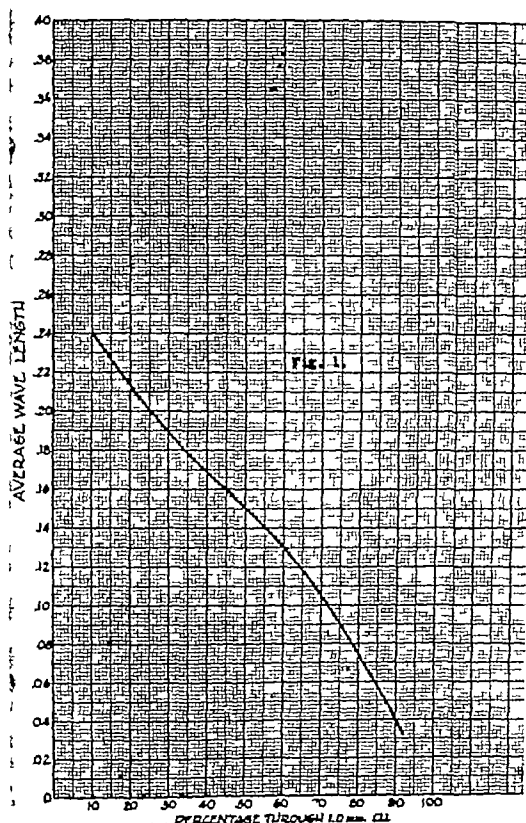


Fig 1 Graph to determine the effective wave length from the percentage of absorption through 1 mm copper

THE DETERMINATION OF QUALITY

The quality of radiation should be expressed in the effective or average wave length. If the latter is known, then the effective or average voltage may be calculated from the equation

$$\frac{h}{\lambda_{\text{eff}}} = V_{\text{eff}}$$

h being the Planck constant 12 354. The effective wave length may be ascertained by Duane's method, although the results of such a determination might be more correctly referred to as the "apparently" average wave length. The percentage of absorption in 1 mm of copper of a given roentgen beam is measured in air with a standardized r-meter. The effective wave length is then read off from a graph (Fig 1). Glasser determines the half value layer in

millimeters of copper, which will reduce the surface intensity measured in r to one-half. From this half value layer, the effective wave length is read off from a graph constructed by Glasser.

Let us assume that the surface intensity with known factors is 48 r per minute, and that after passing through 1 mm of copper it is 40 r per minute. Then the percentage of transmission through 1 mm of copper is 83.3, and the effective wave length of this particular roentgen beam is 0.06 Å. Dividing 12 354 by 0.06 gives 259,000 as the effective voltage. The minimum wave length of the same beam is 0.029 Å, corresponding to the maximum voltage 426,000 as $12\,354 / 0.029 = 426,000$. It is, therefore, a simple procedure to determine the quality of radiation (Table I).

There is, however, a difference in the output of transformers and tubes. Therefore, the type of transformer should be stated, as constant potential, pulsating doubling circuit, mechanical rectifier, coil and so forth. The last two have very abrupt and steep wave forms. The variance in output of constant or pulsating doubling potentials at high voltages is probably less than 10 per cent, while that of mechanical rectifiers and coils probably varies as much as 50 to 60 per cent from the output of the former. Also, there may be a variation in output in different tubes due to glass absorption, which may be corrected by a corresponding reduction of the heavy metal filters, and to distortion in wave form of current and voltage inherent in the tube design.

DISCUSSION OF ABSORPTION

The absorption of rays in a body or medium is the crux of the success of radiation therapy. Absorbed rays become therapeutically effective, absorption is either direct or indirect.

The rays, when impinging upon colloid matter, lose kinetic energy by the recoil, and the emerging ray has a longer wave length. This is the Compton effect or scatter. If the body traversed by the rays has

a volume like the human body or the water phantom, then the Compton effect is not a single occurrence but recurs repeatedly and as often as it strikes colloid matter. Each time, energy is given off which is transformed into an electron when becoming absorbed, and each time the primary ray becomes correspondingly softer, until all of the ray may finally become absorbed.

Rajewsky, in determining the degree and mode of absorption due to the Compton scatter, found the former equal to one Compton scatter in bodies not more than 2 cm deep, and equal to four or five times the single Compton effect in bodies 10 or more cm deep. Rajewsky also discovered that there is a zone in the depth in which Compton scatter and absorption are maximum. This layer or zone of maximum absorption depends on the wave length, the size of the field, and the filter thickness, and is independent of the focus-skin distance. If the voltages of the roentgen ray vary, but the field size and filter are kept constant (Table I), then the following values for maximum Compton absorption are obtained (see next column).

For unfiltered radiation, and for 1.0 mm copper filtered radiation of 200 K V max, the zones of greatest absorption were 3.0 and 5.8 cm, respectively. If the field sizes

Kilovolts Max	Depth of Maximum Compton Absorption
100	2.5 cm
200	5.8 cm
400	9.0 cm
800	10.5 cm

were 10 and 20 sq cm, and the voltage and filter were constant, then the maximum Compton absorption would occur at 4 and 5.8 cm, respectively. If the focus-skin distances were 30 and 50 cm, and the voltage and field size were constant, then the maximum absorption would occur at 5.8 cm, but the intensities would be 22 and 30 per cent of the surface intensity. The maximum absorption zones may be plotted against the effective wave lengths or effective kilovolts (Fig. 2).

These observations indicate that if the size, extent, and depth of the growth are known from measurements of the patient's body or from roentgen films taken in two planes, the voltage may be selected which will bring the growth, by cross-firing, within the zones of maximum absorption.

The custom of designating the depth dose at 10 cm is not sufficient. It should also be supplemented by the designation in centimeters of the zone of maximum absorption, which depends on the wave length or voltage, the filter, and the field size of a given beam of roentgen rays.

TABLE I—SHOWS MAXIMUM VOLTAGE, MINIMUM AND EFFECTIVE WAVE LENGTHS, FILTER, EFFECTIVE VOLTAGE, DEPTH OF MAXIMUM ABSORPTION ZONE, HALF VALUE LAYER, ERYTHEMA SKIN DOSE IN r, WITH BACK-SCATTER AND 10-FRACTION TOLERANCE DOSE IN r, WITH BACK-SCATTER

K V Max	λ Min in Å U	Filter in Mm			λ Eff in Å U	K V Eff	Depth in Cm of Max Absorption Zone	H V L in Mm Cu	ESD with Back-scatter in r	Ten Fraction Tol D in r with Back-scatter
100	0.123				0.35	32	1.75	0.12		
140	0.088	0.25	1.0		0.20	61	3.70	0.50	625	10 × 125
170	0.073	0.50	1.0		0.165	75	4.75	0.75	725	10 × 145
200	0.062	0.50	1.0		0.15	82.5	5.40	0.90	775	10 × 155
200	0.062	0.75	1.0		0.142	87	6.20	1.17	800	10 × 160
200	0.062	1.0	1.0		0.122	102	7.20	1.58	875	10 × 175
200	0.062	2.0	1.0		0.11	112	7.40	1.94	910	10 × 180
230	0.049	1.0	1.0		0.125	98.8	7.00	1.65	860	10 × 170
300	0.041	3.0	1.0		0.084	147	7.00	2.50	1075	10 × 215
400	0.031	5.0	1.0		0.054	229	9.10	4.50	1325	10 × 265
400	0.031	7.0	1.0		0.05	247	9.30	5.00	1375	10 × 275
500	0.025	5.0	1.0		0.05	247	9.30	5.00	1375	10 × 275
600	0.021	5.0	1.0		0.047	263	9.40	5.20	1410	10 × 280
700	0.018	5.0	1.0		0.045	275	9.70	6.00	1450	10 × 290
800	0.015	4.38	2.0	+1.56	0.035	355	10.50	8.20	1575	10 × 315
800	0.015				0.030	412	10.90	9.00	1700	10 × 340

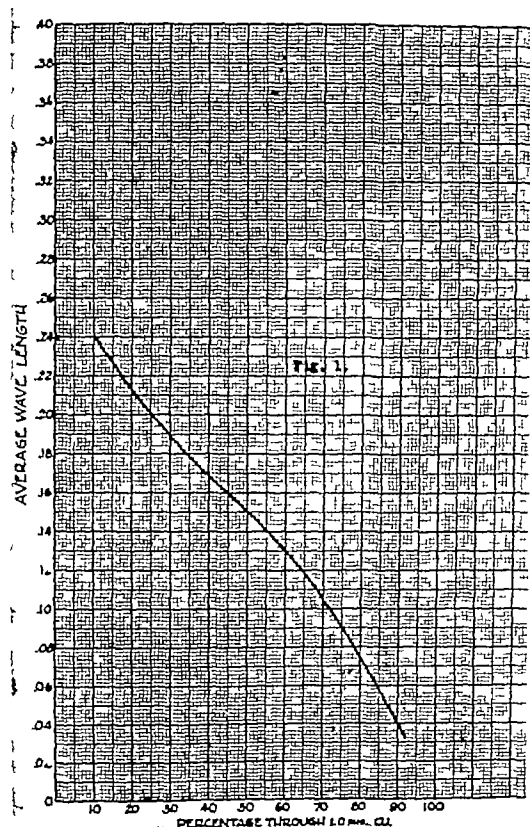


Fig 1 Graph to determine the effective wave length from the percentage of absorption through 1 mm copper

THE DETERMINATION OF QUALITY

The quality of radiation should be expressed in the effective or average wave length. If the latter is known, then the effective or average voltage may be calculated from the equation

$$\frac{h}{\lambda_{\text{eff}}} = V_{\text{eff}}$$

h being the Planck constant 12 354. The effective wave length may be ascertained by Duane's method, although the results of such a determination might be more correctly referred to as the "apparently" average wave length. The percentage of absorption in 1 mm of copper of a given roentgen beam is measured in air with a standardized r-meter. The effective wave length is then read off from a graph (Fig 1). Glasser determines the half value layer in

millimeters of copper, which will reduce the surface intensity measured in r to one-half. From this half value layer, the effective wave length is read off from a graph constructed by Glasser.

Let us assume that the surface intensity with known factors is 48 r per minute, and that after passing through 1 mm of copper it is 40 r per minute. Then the percentage of transmission through 1 mm of copper is 83.5, and the effective wave length of this particular roentgen beam is 0.06 Å. Dividing 12 354 by 0.06 gives 205,900 as the effective voltage. The minimum wave length of the same beam is 0.029 Å, corresponding to the maximum voltage 426,000 as $12\,354 \div 0.029 = 426,000$. It is, therefore, a simple procedure to determine the quality of radiation (Table I).

There is, however, a difference in the output of transformers and tubes. Therefore, the type of transformer should be stated, as constant potential, pulsating doubling circuit, mechanical rectifier, coil and so forth. The last two have very abrupt and steep wave forms. The variance in output of constant or pulsating doubling potentials at high voltages is probably less than 10 per cent, while that of mechanical rectifiers and coils probably varies as much as 50 to 60 per cent from the output of the former. Also, there may be a variation in output in different tubes due to glass absorption, which may be corrected by a corresponding reduction of the heavy metal filters, and to distortion in wave form of current and voltage inherent in the tube design.

DISCUSSION OF ABSORPTION

The absorption of rays in a body or medium is the crux of the success of radiation therapy. Absorbed rays become therapeutically effective, absorption is either direct or indirect.

The rays, when impinging upon colloid matter, lose kinetic energy by the recoil, and the emerging ray has a longer wave length. This is the Compton effect or scatter. If the body traversed by the rays has

dose by 0.2, and the r number to attain a tolerance skin dose by 0.15. For instance, 200 K V with 1.0 mm Cu+1.0 mm Al filter give

for T S D	600 r	0.3 = 180 r,
for E S D	900 r	0.2 = 180 r, and
for Tol S D	1,200 r	0.15 = 180 r

That is, 10×180 r gives the total fraction dose, if 200 K V roentgens are used

The procedure described is adaptable to all roentgen rays, regardless of the type of transformer. It requires the measurement of the percentage absorption occurring in 1 mm of copper. The perusal of the table and curves gives one all factors necessary to determine quality, zone of maximum absorption, and dose. The method has been used for many years, and has always been found to be correct.

CLINICAL OBSERVATIONS

The clinical observations of special significance concerned (1) the palliative action, (2) the systemic reaction, (3) the local changes, (a) in the tumor, (b) in the normal tissues. Permanent results or curability rates cannot be discussed, as only two years have elapsed since the beginning of the ultra-high voltage treatment.

The discussion of the clinical observations may be facilitated by the citation of a few cases picked from the files at random.

Mrs. D. S., clinical No. 4,833, was admitted May 19, 1933, for a recurrent fibromyxochondrosarcoma of the right thigh. The tumor, which had appeared in June, 1931, had been subjected to two operations and two courses of roentgen-ray treatment at other hospitals. It measured 15 cm in length, 10 cm in width, and 10 cm in depth, and was firmly fixed to the upper shaft of the right femur. There was continuous severe pain in the entire leg and inability to use it. The clinical diagnosis was recurrent chondrosarcoma of right thigh, Clinical Group IV. The patient's weight was 95 pounds. Treatment was instituted on May 20. The observations were as follows: complete relief from pain after about 2,500 r, without back-scatter, had been de-

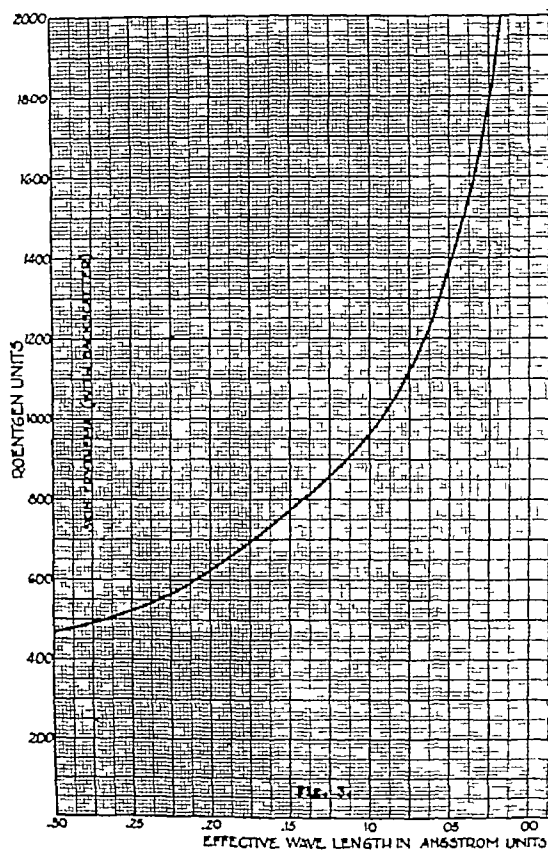


Fig. 3. Graph to determine the radiation erythema skin dose in r with back-scatter for varying qualities or wave lengths.

livered through two ports, slow but perceptible reduction in size after about 4,000 r, without back-scatter, had been given. After treatment the tumor continued to decrease in size, and had resorbed completely by December. The rate of resorption was observed by roentgenograms taken at intervals of eight weeks. The patient's weight increased to 131 pounds. She was able to leave the hospital, walking. The skin reaction could not be studied due to the previous treatment. The condition has persisted up to date. There is now developing a firm induration of skin and muscle, probably due to the repeated x-ray treatments with 200 K V and one course with 800 K V.

Mrs. C. Z., aged 44 years, primipara, clinical No. 5,251, entered the hospital on Feb. 14, 1934, for right-sided, deep pelvic pain. Uterine hemorrhages had begun in June, 1933. Abdominal supravaginal cor-

THE RADIATION DOSE

The determination of the skin dose of roentgens activated by 800 K V peak was

200 The tolerance skin dose is the highest permissible skin dose applicable in one sitting It causes a wet dermatitis within from 14 to 21 days, and should not be re-

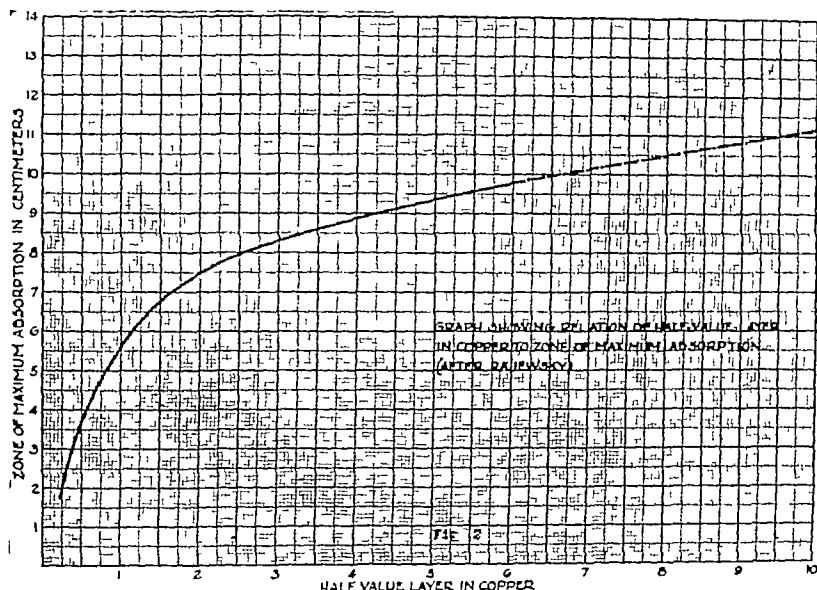


Fig 2 Graph to determine the zone of maximum absorption

not difficult Glasser had found that the number of r to produce the same biologic skin effect, that is, an erythema skin dose, varied with the voltage The higher the voltage, or the shorter the wave length, the more r were needed to produce the erythema skin dose The number of r to produce an erythema skin dose, with 140 K V max and 0.25 mm Cu filter, was 625 with back-scatter, and with 200 K V and 1 mm copper filter, 900 r with back-scatter As the ratio between the erythema skin dose and the threshold skin dose is 3:2, it follows that their values for the threshold skin doses are, for 140 K V max, 427, and for 200 K V max, 600 These r values may be plotted against the wave length, effective kilovoltage, or half value layer (Fig 3) Then, the values may be read off for any quality of radiation

These r values have been employed in all our work, and found correct To obtain the r values for any of the skin doses given, it is necessary only to remember the ratios TSD ESD TolSD = 100 150

peated if applied with maximum kilovoltage of 200 or less If the dose should be repeated, either intentionally or inadvertently, then induration of the tissues and latent ulceration may ensue If a TolSD were applied with 800 K V, then the dose may be repeated once within from four to six months

Fractionation of the dose with ten interval applications, one sitting given every other day, permits the application of an additional 50 per cent r Thus it is safe to apply 10×315 r every other day if 800 K V max r are used, as 1,050 r is the TolSD with back-scatter Therefore, 2,100 r is the TolSD, and 50 per cent additional gives 10×315 r with back-scatter

A simplified method of determining a single dose when ten fractions are to be given to a field within twenty-five days if the threshold, erythema, or tolerance skin dose with back-scatter is known, is to multiply the r number to attain a threshold skin dose by 0.3 to obtain the single fraction dose, their number to attain an erythema skin

these were both associated with multiple metastases to the bones

The observations show the following

(1) There is early relief from subjective symptoms such as pain, distress, discharge and bleeding, which is evident at about the mid-period of the treatment, that is, from the fifteenth day on, as the course is extended over four weeks. The relief is permanent with an arrest of growth, and symptoms reappear with a recurrence

(2) The systemic reactions are mild. Nausea, vomiting, and loss of appetite are infrequent. This is very apparent to one familiar with medium voltage therapy, *i e*, 180 to 220 K V maximum. At the onset of the skin reaction and mucositis, symptoms referable to these complications arise, as burning and itching of skin, frequent and burning urinations, and frequent watery and mucous stools. They appear about the twenty-first day, reach a climax at about the fifth or sixth week, and then gradually abate until complete healing has occurred at about the seventh to eighth week

(3) The effect on the growth is seen early. If no decided reduction in size of growth occurs at about the twenty-first day, then it may be assumed that total arrest or resolution of the growth will not occur

The effects on the normal tissues of the skin and mucous membranes are erythema, epilation, exfoliation and secretion in the former, and erythema, pseudo-diphtheritic mucositis, and watery and mucous discharge in the latter. They disappear at about the sixth to seventh week. The hair regrows almost invariably, the tanning is slight, and complete restitution is seen in the majority of the cases by the end of four to six months. Induration of the skin is not seen. If the general health of the patient had not been unduly lowered, as seen in advanced and infected cancers, the effect on the blood count did not show any marked reduction in the number of red and white cells or the percentage of hemoglobin

COMMENTS

The action of ultra-high voltage roentgen rays is dependent on the energy transfor-

mation, and the formation and absorption of a larger number of electrons in the tissues

Lauritsen has stated that absorption occurs in three different modes (1) Absorption of a narrow beam in air, fly eggs, and other thin material. This can be attained with low voltage, unfiltered radiations. (2) Absorption of a wide beam in the interior of a large body. Such a condition prevails in massive and deep-seated tumors. The use of ultra-high voltages is confined to such cases. (3) Absorption of a wide beam in a superficial area of the body, as the breast. We are concerned with the absorption in massive and internal tumors. Here we are dealing with the total absorption, composed of true absorption and the scatter in the deep tissues, which latter is between 40 and 50 per cent of the total energy. The relation is very complex, and is responsible for the lack of parallelism between roentgens and biologic effects

Lauritsen further has stated that, with 100 K V equivalent, one r represents a total energy absorption of 3,500 ergs per sq cm, and, with 400 K V equivalent, it represents only 2,800 ergs per sq cm. If 500 r at 100 K V equivalent produce a skin erythema, then 1,000 r will be required to produce a similar reaction with 400 K V equivalent. The total energy delivered into the body in the two instances may be compared. At 100 K V equivalent, 500 r represent $500 \times 3,500$ or 1,750,000 ergs per sq cm, at 400 K V equivalent, 1,000 r represent $1,000 \times 2,800$ or 2,800,000 ergs per sq cm. This means that the higher voltage delivers 60 per cent more energy into the body as a whole when the same skin reaction has been produced. Also, a greater fraction of this greater amount of energy will be absorbed at a greater depth with the 400 K V equivalent, while near the surface the absorption is the same for 400 and 100 K V equivalent. This coincides with the findings of Rajewsky that the higher the voltage the deeper will be the zone of maximum absorption

The biologic reaction corresponds almost entirely to the absorbed energy

pus amputation had been performed in November, 1933, but bleeding had continued and became associated with continuous deep pelvic pain in the right side. Biopsy was taken in January, 1934, and showed carcinoma. The cervix was now removed. Pain persisted and the patient was advised to re-enter the hospital. Examination revealed infiltration of the right parametrium, with fixation. Clinical diagnosis was recurrent carcinoma of the cervix, Clinical Group IV. The weight was 107 pounds. Treatment was begun on Feb 15. The pain abated gradually during treatment. The induration in the parametrium became movable, within four months the mass was completely resorbed. The skin, within three weeks, was red, epilated, and exfoliated in places, with wet dermatitis which healed within about another three weeks. The weight had increased to 120 pounds. The pelvic condition has so far remained free from recurrence.

Dr J B, clinical No 5,586, was admitted in December, 1934, with an ulcer of the mucosa of the right cheek of three months' standing. It was about 4.5×4 cm in diameter, and had penetrated the entire cheek including the skin, where an elevation 3 cm in diameter and a livid discoloration were seen. The biopsy revealed a proliferating infected undifferentiated carcinoma. The clinical diagnosis was carcinoma of buccal mucosa, Clinical Group IV. Ultra-high voltage was given. Within two weeks the tumor began to recede, the skin was soft and movable over the mass, and the diameter of the ulcer was about 2 centimeters. At the termination of treatment, the tumor had practically gone, the mucosa was whitish, the skin exfoliating. Within eight weeks there was complete anatomic healing.

The sequence of reactions and clinical results, which was the same in these cases, responding to this type of therapy, was as follows: (1) Palliation occurred with onset of reduction in size of tumor, and appeared about the mid-period of treatment. (2) Absorption of the growth appeared within from two to six months. The rate

depends on the size and location of growth and on the presence of connective tissue cells and the modification of cells. (3) There is gain in weight and strength due to the attainment of freedom from symptoms and degenerating processes. (4) The local changes in the skin consist of epilation, erythema, and exfoliation with wet dermatitis in most of the cases. The mucosa of the vagina, bladder, rectum, and oral cavity assumes a deep red color. 50 per cent of the dose has been given. A white pseudo-membranous growth appeared at the end of the treatment. Frequent painful urinations, and diarrhea were observed during pelvic radiations, along with sickness and burning in the gastrointestinal tract. These conditions subside within four to six weeks.

Blood examinations have been made routinely and at stated intervals. Erythrocyte count, hemoglobin percentage, leukocyte and differential count have been determined before the beginning of treatment and after the fifth, tenth, twentieth, fourteenth, eighteenth, and twentieth treatments in 60 consecutive cases. Significant decreases in the erythrocyte count (5 or more per cent) occurred in only 10 cases, which were practically always associated with advanced malignant disease. In 19 instances there was a definite increase in the number of erythrocytes during the course of treatment. The remaining cases showed no significant changes.

Changes in the erythrocyte count were usually but not always accompanied by a corresponding change in the percent hemoglobin. In three cases, the hemoglobin percentage fell 10 to 15 per cent without any decrease in the erythrocyte count.

Changes in the leukocyte count occurred more frequently and were more pronounced than the changes in the erythrocyte count or hemoglobin. The leukocyte count dropped to or below 4,000 in 21 cases. In 19 of these cases, the leukopenia was transient and the differential count remained normal. Only two instances of stubborn leukopenia were observed.

OSTEOPOIKILOSIS

By I SETH HIRSCH, M D , *New York City*

OF the many obscure benign systemic bone diseases, osteopoikilosis (ostitis condensans generalisata or osteopathia condensans disseminata) is one of the most interesting. It is a congenital hereditary condition in which there are found small areas of compact bone within the cancellated structures of almost all the bones except the skull. These areas are usually located in the epiphyseal and metaphyseal portions of the bone.¹

The lesions are of two types

1 *Nodular Type (punctate)*—Numerous small bead-like dense sharply circumscribed nuclei of compact bone

2 *Linear Type (striæ)*—Sharply defined linear areas of dense bone, disposed more or less parallel to the axis in the metaphyses

Either of these lesions may exist in pure form or both types may be present either in the same or in different bones in the same subject

Symptomatology—The disease is not associated with local or general symptoms and is usually discovered accidentally. Aside from the changes above described, the bone is normal in all respects. There is no tendency to fracture. The foci do not enlarge with the growth of the bone, but appear to assume greater density with advancing age.

The disease has been found in individuals with congenital syphilis (Bloom),² achondroplasia (Guellhars and Mallaret), abdominal tuberculosis (Van Dorp and Beucker), Busche and Ollendorf and also

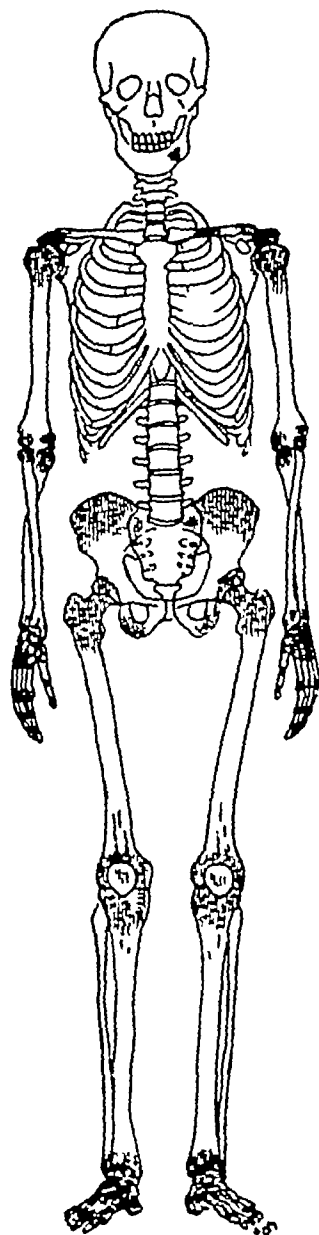


Fig 1 Diagram showing the distribution of the lesions

¹ Single isolated nodules (the so-called compact islands) or striæ are not an uncommon finding. The connection between these and the generalized disease is not understood.

² Bloom describes a case of osteopoikilia in an adolescent of 17 who presented many cardinal symptoms of congenital syphilis. No changes were found in the mother, the two younger sisters and a younger brother, except in the case of the next younger sister in whom a single focus 2 mm in diameter was found at the base of the second metacarpal of the left hand.

Windholz reported the association of osteopoikilosis with a disease of the skin "dermatofibrosis lenticularis disseminata," but this association is by no means constant.

in more mature cancers. Hence, deep radiation therapy requires the use of such a voltage that the tumor is brought within the zones of maximum absorption.

The object of the further development of radiation therapy should be the development of transformers to safely deliver any voltage desired, and the construction of roentgen tubes to activate voltages of wave lengths close to those of radium. Radiation intensities should not only be meas-

ured on the surface but especially at the place where the action is desired.

The clinical observations made with 800 K V seemingly run parallel to the biologic reactions, which are superior to those seen with low and medium voltage roentgen-ray therapy, and result from the increased absorption in the depth of the body from ultra-high voltage roentgen therapy in comparison to that occurring in medium and low voltage therapy.

Distribution—The nodules have been found in all the bones except the skull. They are located in the epiphyseal ends, but have been reported in the midportion of the diaphysis of the clavicle and in the lower jaw (Bloom)³ (Fig 1)

The bone structure in the neighborhood of these nodules may be normal, but usually the lamellæ of the spongiosa are thickened. In some of the nodules, the periphery is more dense than the center.

The linear lesions are disposed more or less parallel to the axis of the ends of the long bones, in the wings of the sacrum, in the iliac bones, and scapulæ. These striæ are for the most part located in the metaphyses, beginning at the epiphyseal line and extending for a varying distance into the diaphysis. The direction of the striæ corresponds to the architecture of the cancellated structure of the particular bone. Thus in the long bones they are parallel to the long axis, but in the wing of the ilium they are disposed radially. In the scapula the radiations extend outward from the glenoid process. They are evenly disposed throughout the whole thickness of the cancellated structure.

CASE REPORTS

Two cases are here reported, a father aged 40 and his son aged 16. A daughter showed no evidence of the lesion. The history was entirely negative. The father appeared for examination because of an injury to the foot and the examination disclosed the disease. The children were then examined. The boy shows the pure nodular lesion, but in the bones of the father mixed lesions are found in several locations.

The nodular foci in both these cases are most numerous in the bones of the hands and feet (Figs 2 and 3). In the pelvis they lie near the acetabulum and the symphysis.

In the neck of the femur the nodules follow the shaft structure. The foci are thickest near the joint surfaces (Fig 4).

In the upper end of the femur they are numerous in the head, neck, and trochant-



Fig 3 Distribution of the lesions in the bones of the hands. An area of eburnated cortex is found in the terminal phalanx of the second finger and in the first metacarpal.

ers. In the lower end of the femur they are confined to the condyles, the cancellated structure of which shows coarsened trabeculæ (in the father).

The upper end of the tibia shows a few nodules and marked thickening of the lamellæ. The head of the fibula is free. The lower third of the fibula and the tibia show thickened trabeculæ and nodules. The lower end of the tibia in the child shows the linear lesion without nodules.

All the bones of the foot contain nodules. The second and third metatarsals of the father show definite cortical thickening, irregularly disposed as longitudinal bands (Fig 2). There are nodules in the ribs. All the bones of the shoulder girdle show the changes in a characteristic manner, a few nodules being present in the lower humeral diaphysis. The bones of the elbow joint show nodular lesions.

The bones of the wrist joint and all the bones of the hands show the typical changes though the nodules are most numerous in the carpal bones. The first metacarpal bone, the phalanges, and the lower end of the right ulna of the father show areas of

³ It is interesting to note that the two centers of ossification first to appear in the fetus are at these sites.

and the majority of the cases show no sclerodermatous changes

Pathology—Schmorl reported that the close packing of the lamellæ The thickened trabeculæ may be arranged concentrically around blood vessels



Fig 2 Showing the distribution of the lesions in the bones of the foot. The irregular thickenings of the cortex of the second and third metatarsal bones resemble the lesions of melorheostosis

foci consist of numerous bone trabeculæ of various thicknesses arranged compactly but regularly, the bone resembling the structure of the spongiosa and not that of the cortex. These foci of compact bone appear to be arranged in the axis of the main trabeculæ. The trabeculæ are slightly thicker than those of the normal bone in that particular region. The "compactness" of the nodules as visualized in the roentgenogram is due both to this and to

The microscopic findings give no clue to the genesis of the disease. Schmorl believed that an endochondral origin can be discounted because the foci show no connection with the endochondral zone of growth and suggested a developmental rest—*islands of primitive bone*.

The blood phosphorus and calcium determinations are normal.

Epiphyseal ossification and bony development is normal.

years, which also showed multiple osteochondromas and diffuse cortical lesions suggesting osteitis fibrosa

Analogous combinations are present in a series of other hereditary systemic diseases of the skeleton, for instance, blue sclera



Fig 5 Nodular type of disease In the head of the humerus and in the glenoid process of the scapula and in the acromial end of the clavicle and scapula, are numerous dense, oval and rounded nuclei of compact bone

Further, Kahlstorf and also Branchini have pointed out the presence of lesions resembling the monomelic eburnizing osteitis (longitudinal condensation of the cortex) associated with osteopoikilosis. The ulna, metatarsals, metacarpals, and phalanges of the father in the case here reported showed the changes of this disease also known as melorheostosis, or flowing hyperostosis.

It is interesting to observe that many cases of melorheostosis show associated osteochondromas and exostoses, for it suggests that the bone nodules of osteopoikilosis may be a dyschondroplasia of the same order—the displaced cartilaginous nuclei being located within the bone-enostoses.

These associations would tend to point to a disease of the mesenchyme and the occasional simultaneous occurrence of osteopoikilosis and lenticular disseminated dermatofibrosis shows that the responsible gene-mutation affects not only the osseous system but also the remaining mesenchyme

with osteopsathyrosis. It must also be borne in mind that the endocrine deficiency in the mother may be related to the congenital bone dystrophies. Osteopoikilosis has been observed in a fetus four months old.

The question deserves further study. It is necessary, besides delving more deeply into the history and objective findings, to submit the families of individuals with this and allied bone diseases to a radiologic investigation. Such findings may help to clear up the nature of many now obscure lesions by showing an interrelationship between them, for the many apparently separate entities may well be the varied phases of a single disease and due to the same etiological factor.

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diffuse, irregular, cortical, eburnating sclerosis, band-like in shape and involving one aspect of the bones

osteopoikilosis described by him, various manifestations of the dyschondroplasia exist (cartilaginous exostoses, isolated meta-



Fig 4 Showing the distribution of the lesions in the pelvic bones and femora

Comment—The etiology of the disease is unknown. Both types of lesion are hereditary. Awalischwili reported a case in which seven members of one family had the lesion. The anomaly has been found by Heilborn in a fetus of four months. The lesion is more common in males. It may exhibit itself in different forms in various members of the family. Thus, in Voorhoeve's report, a father had the nodular type of disease and a son showed the linear lesions.

The lesions apparently bear a relation to other forms of bone or cartilage dystrophies. On this basis, these lesions may be due to inclusions of cartilage which have retained their primary calcification.

Voorhoeve presents interesting observations in the association which may exist between osteopoikilosis and dyschondroplasia, pointing out that in the cases of

physal areas of abnormal transparency, slight enlargement of the metaphysis), and that, on the other hand, in the observed cases of dyschondroplasia small zones of compact bone comparable to the nodular or the striated form of osteopoikilosis are sometimes found. He concludes that the latter should be classified with the group of the dyschondroplasia.

In the group reported by Wilcox the father and son showed the typical lesions, but the sister showed the skull lesion associated with generalized osteitis fibrosa of the Paget type, in the frontal bone and in the bones of the middle and anterior fossa of the skull. There were apparently no other changes in the body. I have pointed out the hereditary character of generalized osteitis fibrosa of the Paget type.

Nichols and Shiflett reported on a case of osteopoikilosis, observed for seventeen

years, which also showed multiple osteochondromas and diffuse cortical lesions suggesting osteitis fibrosa

Analogous combinations are present in a series of other hereditary systemic diseases of the skeleton, for instance, blue sclera



Fig 5 Nodular type of disease In the head of the humerus and in the glenoid process of the scapula, and in the acromial end of the clavicle and scapula, are numerous dense oval, and rounded nuclei of compact bone

Further, Kahlstorf and also Branchini have pointed out the presence of lesions resembling the monomelic eburnizing osteitis (longitudinal condensation of the cortex) associated with osteopoikilosis. The ulna, metatarsals, metacarpals, and phalanges of the father in the case here reported showed the changes of this disease also known as melorheostosis, or flowing hyperostosis.

It is interesting to observe that many cases of melorheostosis show associated osteochondromas and exostoses, for it suggests that the bone nodules of osteopoikilosis may be a dyschondroplasia of the same order—the displaced cartilaginous nuclei being located within the bone-exostoses.

These associations would tend to point to a disease of the mesenchyme and the occasional simultaneous occurrence of osteopoikilosis and lenticular disseminated dermatofibrosis shows that the responsible gene-mutation affects not only the osseous system, but also the remaining mesenchyme

with osteopsathyrosis. It must also be borne in mind that the endocrine deficiency in the mother may be related to the congenital bone dystrophies. Osteopoikilosis has been observed in a fetus four months old.

The question deserves further study. It is necessary, besides delving more deeply into the history and objective findings, to submit the families of individuals with this and allied bone diseases to a radiologic investigation. Such findings may help to clear up the nature of many now obscure lesions by showing an interrelationship between them, for the many apparently separate entities may well be the varied phases of a single disease and due to the same etiological factor.

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CASE REPORTS AND NEW DEVICES

OSTEOGENIC SARCOMA OF THE CLAVICLE TREATED WITH RADIATION AND FEVER THERAPY

By HOWARD P DOUB, M D, *Detroit, Michigan*
Department of Roentgenology, Henry Ford Hospital

The results of the treatment of osteogenic sarcoma have always been disappointing regardless of the therapeutic method employed. Amputation, followed by irradiation or Coley's toxins or both, has been the method of choice

beneficial result was obtained from the use of these toxins. If this were true, the fever could be produced and controlled much more surely and exactly by mechanical means at our disposal than by the introduction of toxins into the body. The results of the work of Warren (1) in attempting to determine the thermal death time for transplantable animal tumors would seem to present experimental evidence that high fever can have a definite deterrent effect upon tumor cells.

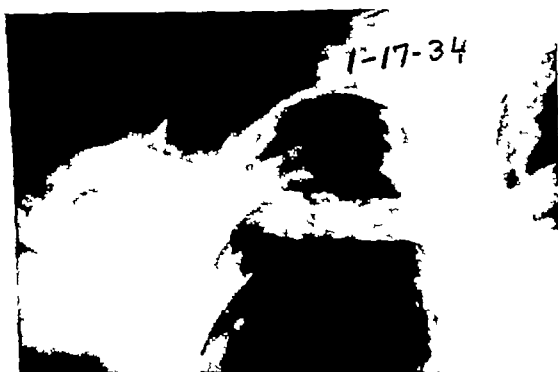


Fig 1 Right clavicle showing pathological fracture with moth-eaten appearance of the bone and periosteal changes



Fig 2 Three and one-half months after beginning of treatment, showing beginning union with recalcification of bone

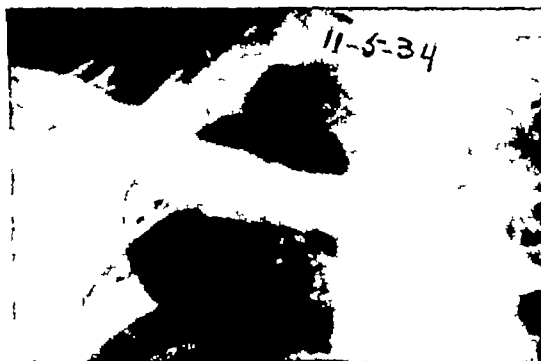


Fig 3 Nine and one-half months after beginning of treatment, showing complete union, with disappearance of the pathological fracture and of the tumor



Fig 4 Eighteen months after beginning of treatment, showing complete restoration of bone, with disappearance of the tumor. Patient clinically well

by several investigators who have recorded their results in the treatment of these cases. The administration of Coley's toxins, which consist of mixed toxins of erysipelas and *Bacillus prodigiosus*, is usually followed by definite elevation of the patient's temperature, with the usual symptoms of foreign protein reaction. We have felt for some time that the fever might be the active agent in whatever

In the case under consideration the tumor involved the clavicle, which is a difficult site for excision. It was decided, therefore, to administer both fever therapy and irradiation therapy in the hope that the fever therapy might render the tumor cells more radiosensitive. Fever therapy was administered at weekly intervals and deep x-ray therapy at intervals of two months.

CASE REPORT

Male, aged 30, laborer, first seen at this hospital Jan 17, 1934. History of mild injury to shoulder two months previously, with later some swelling which disappeared and recurred several times. Two days before examination, while opening a car door, he experienced pain in the region of the right clavicle which persisted on motion.

Examination revealed a mass about two and a half inches in diameter near the inner third of the right clavicle. There was no redness of the skin, but considerable tenderness. The mass was hard but not movable. The shoulder drooped and there was loss of active motion in the shoulder.

X-ray examination of the right clavicle revealed a pathological fracture of the clavicle at the junction of the middle and inner thirds. The bone edges had a moth-eaten appearance with considerable decalcification. There was evidence of some periosteal bone production along the superior margin of the bone. This suggested a primary sarcoma of the clavicle.

A biopsy of the tumor was then done and a diagnosis of osteogenic sarcoma was returned.

The x-ray examination of the lungs was negative for evidence of metastases. The Wassermann was negative. All other examinations were negative.

Therapy—This consisted of four series of deep x-ray therapy applied through the tumor anteriorly and posteriorly, using 200 K V with 0.5 mm copper and 1 mm aluminum filtration at 50 cm FSD. A full erythema dose was applied anteriorly and approximately three-fourths of that amount posteriorly. An erythema dose is figured at 750 r units measured in air and given in one sitting.

Fever therapy was administered at weekly intervals. A total of eight treatments was given, each consisting of a five-hour treatment during which the fever was constantly maintained at a temperature from 105 to 106 degrees F, rectal temperature. This treatment was administered by means of the Kettering Hypertherm which has been made available to us through the courtesy of Mr Charles F Kettering.

Three months after the initial treatment there was roentgenologic evidence of partial recalcification, with thickening of the bone at the point of fracture. The patient had, in the meantime, recovered the use of his arm and was free from pain. In five months the fracture was completely united and there was considerable thickening of the bone at that point. At this time there is a fusiform thickening of the bone at the point of fracture, but no evidence of the tumor can be seen on the roentgenogram. There is no pain or disability pres-

ent. The patient has been working constantly in a large industrial plant since August, 1934, and is in excellent condition at the present time.

We realize that but a short time has elapsed since the beginning of therapy, but it is our impression that the rate and completeness of healing of the bone defect have exceeded those of any similar case we have treated by means of radiation therapy alone. We present this case in the hope that other radiologists will give this combined treatment a thorough trial if the opportunity presents itself.

REFERENCE

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TELEORADIOGRAPHIC UNIT EMPLOYING A SINGLE X-RAY TUBE FOR BOTH THE AMBULATORY AND BED PATIENT

BY WALTER W FRAY M S M D Rochester, N Y

From the Department of Medicine Division of Radiology of the University of Rochester School of Medicine and Dentistry and Strong Memorial Hospital.

Ceiling-mounted tubes for chest teleoradiography have been employed in a few of the larger hospitals for several years. A unit of this type has been recently described by Feaster (2), which permits centering the tube over the chest with the patient in a recumbent position. A unit almost identical with this constructed by Warren (3) was in use in the radiographic division for about four years. We found the unit convenient in many ways. The patient does not need to be greatly disturbed and, therefore, many types of examinations are requested by the clinical services which would otherwise be omitted. Such a unit, in addition to the extra cost of a second tube, due to the individual tube characteristics, requires a separate calibration. This type of unit suffers the further handicap that the tube cannot be tilted to obtain satisfactory radiographs on individuals who are in a semirecumbent position.

We have always felt that the ceiling mounted tube is much to be preferred, in spite of these disadvantages, to the old method of removing dangerously ill patients from bed, or obtaining chest films at short object film distances, thereby rendering comparison of the emergency type of film wellnigh impossible with the films either previously or subsequently obtained. For the past two years we have been using a new type of unit which has all the advantages of our old ceiling-mounted tube as regards teleoradiography (in a dangerously ill

patient) without the disadvantages mentioned above. With our present set-up we use only one tube for both the erect and the recumbent position, thereby eliminating switching devices for energizing the ceiling tube.

the tube to the ceiling level by means of an extension handle, readily grasped by the operator at standing height. When used for chest radiography in the erect position, the tube carriage is brought down to the level of the chest and

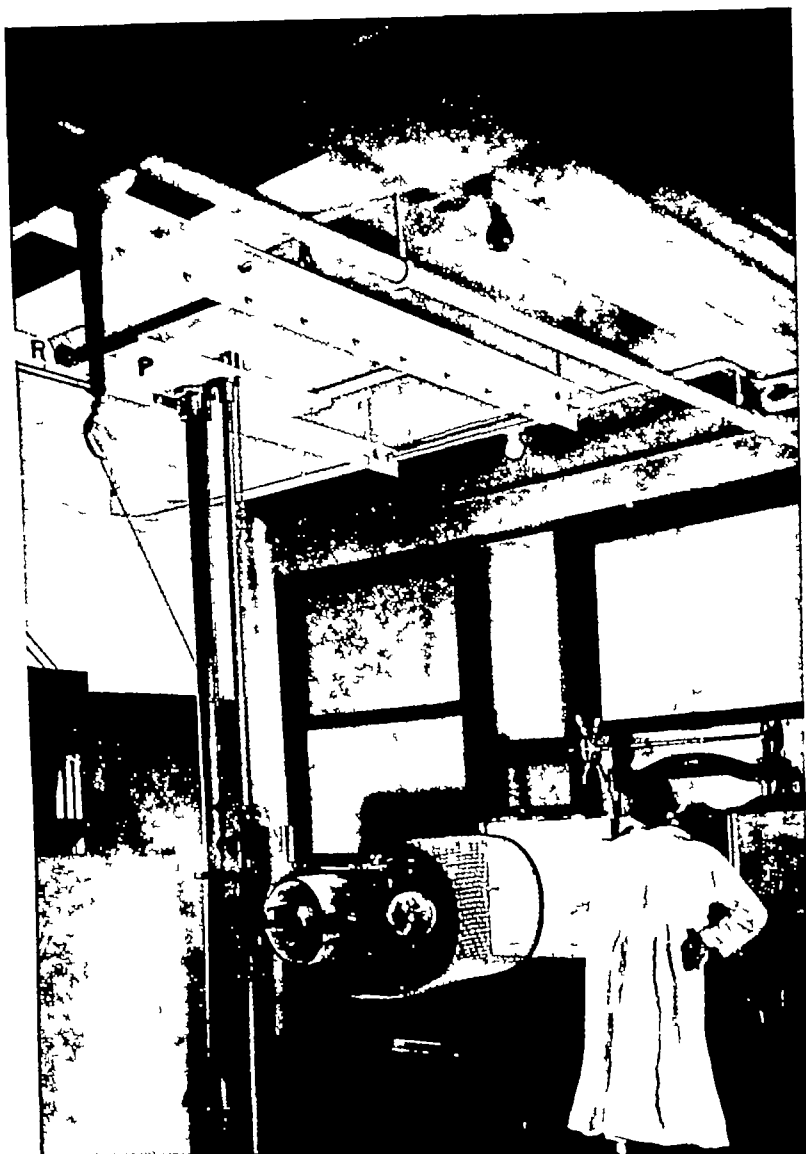


Fig 1 Position of unit for the ambulatory patient. The tube carriage is elevated and lowered by means of the strap handle (H). The tube stand is fastened by means of a collar to the plate (P). The latter is supported by two cross members with rollers (R) which travel along the overhead track (S). The steel tubing contains counter balancing weight.

The X-ray tube is supported on a conventional type of tube carriage. In place of the usual tube stand a long piece of Shelby tubing of proper diameter to conform with the size of the guard ring of the tube carriage reaches from the ceiling to the floor. The unusual length of this tubing permits the elevation of

the carriage swung through the usual 90 degree angle in order to face the target of the tube toward the patient.

This piece of equipment differs from the usual ceiling-mounted tube in that, in addition to the tube carriage the tube stand itself is ceiling-mounted, substituting for the short tube stand

post a long piece of Shelby tubing which reaches from the ceiling to the floor. To prevent the bending or buckling which might occur due to the condition of imbalance resulting from the weight of the tube and its carriage on one side

elongated tube stand upon a ceiling track running in the direction of the plate changer, to permit varying the target-object distance.

This was done by fastening the top of the two posts to a steel plate by means of collars,

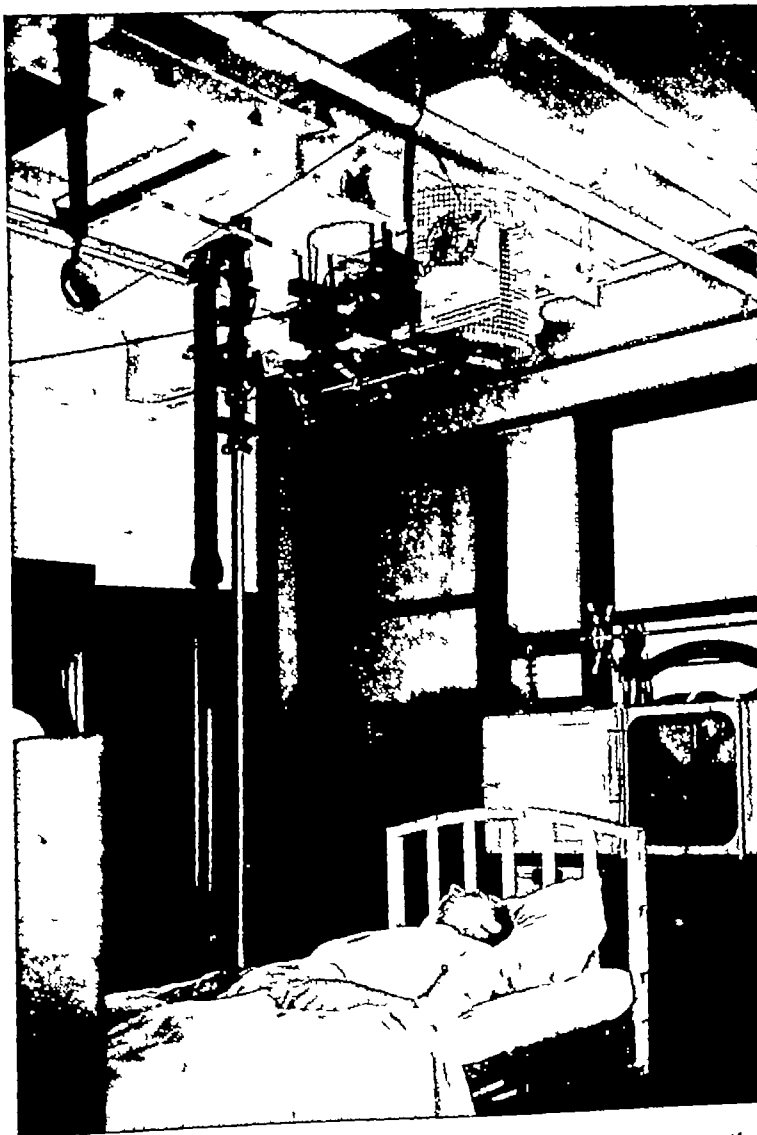


Fig 2 Position of the unit for bed patient. The tube carriage is in the elevated position, 6 feet above the film

of the unit, the Keleket type of stand was employed with the familiar double post arrangement. The larger one of these posts, which contains the counterbalancing weight for the tube and its carriage, is 2.5 inches in diameter (external measurement, with a wall thickness of about three-eighths inch). The other post is solid cold-rolled steel. In order to produce greater flexibility it was decided to mount this

the plate itself being rendered mobile by means of four roller bearings. The tracks along which these run are fastened to the inner side of heavy angle iron, preventing any chance of the mechanism becoming derailed. By mounting the track to the ceiling (2 feet apart), a level run can be obtained which is impossible with the uneven surface of our floor. A track upon the floor was avoided because such equipment

would prevent easy manipulation of beds and would be constantly underfoot. The run is long enough to permit varying the target-film distance from two to ten feet. For bed patients this distance can be varied up to six feet (ceiling height limit). A turn screw through the collar at the base of the tube stand makes contact with the floor by means of a broad flat button, stabilizing the lower portion of the equipment. An automatic safety lock (Bishop, 1) has been added to the equipment to avoid disaster in the event that the cable connecting the tube carriage and counterbalancing weight should break. The illustrations demonstrate the manner in which the equipment is used for both ambulatory and bed cases. The track, while helpful in the event that the target-film distance is changed in carrying out different technics, is not obligatory for routine chest work. The unit may be permanently fixed between the ceiling and floor for work of the latter character.

To Mr. William T. Hill, deceased, formerly our chief technician, the writer owes a very real debt for his many helpful ideas and his energetic assistance during most of the period of construction of this unit. He regrets particularly that Mr. Hill's sudden death prevented him from seeing the unit placed in practical use. Grateful acknowledgment is also made of the assistance of Dr. S. L. Warren and Mr. F. W. Bishop.

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EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

ARTIFICIAL FEVER AS A THERAPEUTIC AGENT

Throughout the course of medical history heat has always been a prominent therapeutic agent for the prevention or cure of various diseases. In most instances it was used in an empirical manner without any thought of producing fever in the patient. Paradoxically fever has, from the earliest days, been looked upon with suspicion and alarm and antipyretics have been freely used to combat its supposedly harmful effects. Only occasionally did some observer record cases in which he believed fever had been beneficial.

Forty-seven years ago Welch stated that it would be very unusual if Nature had developed and retained fever to such an extent if it did not serve some useful purpose. Statements such as this created little discussion until Wagner-Jauregg, in 1918, conclusively demonstrated that malarial fever could be successfully employed in the treatment of the hitherto hopeless cases of dementia paralytica. His favorable results were soon confirmed by other investigators throughout the world.

The mortality associated with the use of malaria and the inherent difficulties associated with its safe usage was a stimulus to investigators to search for other means of producing fever. Typhoid vaccine has been used rather widely for this purpose. Inoculation with the organisms of rat-bite fever and relapsing fever has also been used. The injection of foreign proteins also causes an elevation of body temperature. All these methods are objectionable in that the temperature increase is uncertain and in some instances the fever proved to be uncontrollable.

The next logical step then was the production of fever by physical methods which could be easily controlled. Among these physical methods which have been used successfully are hot baths, diathermy, radiothermy, inductothermy, radiant light, and air-conditioned cabinets. Hot baths are likely to prove very debilitating unless the treatment time is quite short. With the use of diathermy the technical difficulties necessary to prevent skin burns made it a difficult method to use. Radiothermy has been used very successfully but the

apparatus is somewhat complicated to operate and requires special care of the patient for rapid removal of the perspiration. Inductothermy is being used with success by many workers. Radiant light cabinets employing either infra-red generators or carbon-filament lamps are cheap to build but are somewhat slower in temperature elevation. Air-conditioned chambers have made their appearance in the past few years and have proven very successful. The temperature of the patient is at all times controlled within close limits and the patient is as comfortable as it is possible to be under conditions of artificial fever therapy.

Some of the physiological changes attending artificial fever have been recorded by investigators in this field but much remains to be done before the meaning of fever therapy can be completely understood and its benefits evaluated. There is definitely increased blood velocity. The pulse rate is increased approximately 8 to 10 beats a minute for each degree of fever above normal, but there is considerable individual variation. There is a corresponding increase in the respiratory rate. The blood pressure frequently rises slightly at first but falls later during the treatment.

The red blood cell count shows little or no change. There is an initial drop of the leukocyte count followed by an elevation of several hundred per cent over a 12-hour period. Simpson found a marked decrease in the blood chlorides and instituted the administration of sodium chloride during the treatment to compensate for this loss. There was also loss of chlorides in the gastric secretion. Many other physiological changes have been noted, but space forbids a fuller discussion of this aspect of the problem.

The field of fever therapy is so new that it is impossible to accurately evaluate its limitations at the present time. Wagner-Jauregg's success in the treatment of dementia paralytica has been confirmed by so many investigators that it would seem that fever therapy will be a permanent adjunct in the treatment of this disease and of all types of central nervous sys-

tem syphilis The work of Warren, Boak, and Carpenter in determining the thermal death time of the gonococcus has helped to standardize the dosage required to eradicate disease produced by this organism Fever therapy appears to function equally well in the primary disease and its complications

The recent report by Whitney of success in the treatment of corneal ulcer and acute iritis seems to offer much hope for the future treatment of these conditions Multiple sclerosis is being treated on an experimental basis by a number of investigators The work of Schmidt would seem to indicate a considerable degree of temporary benefit It is too early to estimate the permanency of these results Recent reports at the fever conference in Dayton, Ohio, indicate that fever therapy is a very valuable therapeutic agent in the treatment of chorea

The value of fever therapy in the treatment of atrophic arthritis cannot be accurately appraised at this time It would seem that it is a useful adjunct in some cases and of no value

in others In gonorrheal arthritis good results are reported in about 90 per cent of the cases

The work of Warren on the effect of fever alone and in combination with irradiation therapy is of the greatest importance to radiologists He found experimental evidence of a "thermal death time" for transplantable animal tumors at high febrile temperatures Treatment of tumor patients seemed to bear out the conclusions arrived at on experimental animals

Experiments are being carried out on the effect of fever therapy in many other diseases, but the results mentioned above will indicate to some extent the results which have been achieved so far in this relatively new field Much fundamental research work remains to be done in this field Now that adequate facilities are available for the safe production and maintenance of fever the need is for careful and honest observation and evaluation of the effects of fever in health and disease

HOWARD P DOUB, M D

ANNOUNCEMENT

NEXT ANNUAL MEETING

DEC 2-6, HOTEL STATLER, DETROIT

LOCAL COMMITTEES

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NOTES IN REGARD TO PROGRAM

The program for the Annual Meeting is taking form, and, while the following announcements are by no means complete, they serve to indicate the character of the program as it will be presented at Detroit in December

SYMPOSIA

THERAPY AND SUPERVOLTAGE SYMPOSIUM¹

Leaders FRANCIS CARTER WOOD, M D,
and ROBERT R NEWELL, M D

- 1 LEUCUTIA, TRAIAN (*by invitation*) Developments in Apparatus for Roentgen Therapy at Very High Voltages (Or shall we admit the new term and write "Developments in Supervoltage Roentgen Therapy Apparatus"?)
- 2 TAYLOR, L S Report on Conference on Supervoltage Therapy at Minneapolis
- 3 EXNER, FRANK M (*by invitation*) Some Physical Problems in Roentgen Therapy at High Voltages (The title may be changed but the paper is designed to cover more than a narrow experimental field)
- 4 FAILLA, GIOACCHINO Dosimetry in the Supervoltage Range
- 5 PACKARD, CHARLES (*by invitation*) Some Biologic Problems in Roentgen Therapy
- 6 HOLTHUSEN, H (*by invitation*) Importance of the Time Factor in Radiation Therapy
- 7 QUIMBY, EDITH H Recovery Rate in Skin for Gamma Rays and Soft and Hard Roentgen Rays
- 8 HENSHAW, PAUL S (*by invitation*) Influence of Wave Length upon Depth Dose as Measured by Physical and Biological Means
- 9 SNELL, GEORGE D (*by invitation*) Roentgen Injuries to Genetic Apparatus in Mammals as Bearing upon the Problem of Protection of Personnel
- 10 MUDD, SEELEY G Clinical Experience in Supervoltage Roentgen Therapy

SYMPOSIUM ON THE ENDOCRINE GLANDULAR SYSTEM

Leader W HERBERT MCGUFFIN, M D

- 1 PAUL C HODGES, M D, University of Chicago Skeletal Changes in Disturbances of the Parathyroid Gland
- 2 E A MERRITT, M D, and I LATTMAN, M D, Washington, D C Roentgen Therapy of Parathyroidism
- 3 Professor J B COLLIP, M D, Department of Biochemistry and Pathological Chemistry, McGill University, Montreal Review of the Early Scientific Aspects of Pituitary Hormones and the Significant

Facts in Regard to Their Influence on Bone Growth

- 4 HECTOR MORTIMER, M D, McGill University, Montreal Roentgenographic Demonstration of the Effects of Pituitary Hormones on Bone Growth
- 5 L J MENVILLE, M D, New Orleans, La. A Study of a Series of Cases after Irradiation of the Pituitary Gland
- 6 Associate Professor H C SHEPARDSON, University of California, San Francisco Importance of Bone Age Studies in Endocrine Diagnosis
- 7 DAVID STEEL, M D, St John's Hospital, Cleveland, Ohio Radiotherapeutical Treatment of Ovarian Tissue in Cases of Metastatic Malignancy Involving the Osseous System (provisional title)
- 8 ALEXANDER BRUNSCHWIG, M D, University of Chicago The Relationship between Biologic Action and the Intensity of the X-radiation Producing It An Experimental Study on Rat Testes

UROLOGIC SYMPOSIUM

Leader B H NICHOLS, M D

- 1 MOSES ZWICK, M D, New York City Intravenous Pyelography in Children
 - 2 H W FLAGGEMEYER, M D, Detroit (*Title to be announced*)
 - 3 U V PORTMANN, M D, Cleveland, Ohio X-ray Therapy of the Urinary Tract.
 - 4 B H NICHOLS, M D, Cleveland, Ohio Roentgenology in Determining the Cause of Hematuria
- (Probably one other speaker will be announced later)

SYMPOSIUM ON DISEASES OF THE CHEST

- 1 DAVID EHRLICH, M D, New York City Primary Carcinoma of the Lung
- 2 CHARLES F GESCHICKTER, M D, Baltimore, Md Pulmonary Neoplasms
- 3 JOHN T FARRELL, JR, M D, Philadelphia Some Phase of Pulmonary Neoplasms (*Exact title to be announced later*)
- 4 SAMUEL BROWN, M D, Cincinnati, O X-ray Diagnosis and Treatment of Pulmonary Tumors
- 5 W WALTER WASSON, M D, Denver, Colo Atelectasis and Differential Diagnosis
- 6 ROY ALDEN CARTER, M D, Los Angeles, Calif Pulmonary Mycosis
- 7 ERNST A POHLE, M D, Ph D, Madison, Wis Routine Roentgen Examinations

¹Tentative, as of Aug 3 1935

of the Chest of Patients Admitted to the State of Wisconsin General Hospital during a Three-Month Period

SYMPOSIUM ON BONE LESIONS

Leader CHARLES G SUTHERLAND, M D

- 1 H W MEYERDING, M D, Rochester, Minn Bone Tumors Diagnosis and Treatment
- 2 A U DESJARDINS, M D, Rochester, Minn Radiotherapy of Bone Lesions
- 3 JOHN D CAMP, M D, Rochester, Minn Inflammatory and Non-malignant Lesions of Bone
- 4 R J L KENNEDY, M D, Bone Lesions in Children

(One other speaker will be announced later)

SYMPOSIUM ON GASTRO-INTESTINAL CONDITIONS

Leader LEO G RIGLER, M D, University of Minnesota, Minneapolis

- 1 B R KIRKLEN, M D, Mayo Clinic, Rochester, Minn Fluoroscopic Examinations of the Stomach and Duodenum
- 2 JOHN R CARTY, M D, New York City Roentgenographic Technic in the Examination of the Stomach and Duodenum
- 3 ARTHUR SINGLETON, M B, Toronto, Canada Pre-pyloric Ulcers
- 4 EUGENE P PENDERGRASS, M D, Philadelphia Normal Small Intestines and Technic of Examinations
- 5 LEWIS G COLE, M D, New York City Abnormality of Small Intestines
- 6 H P DOUB, M D, Detroit Small Intestinal Tumors

Arthur C Christie, M D, of Washington, D C, who will deliver the Carman Lecture, has not yet given a definite title to his subject

The Symposium on Treatments by Albert Souland, M D, and also the Symposium on Treatments by Edwin C Ernst, M D, have not yet been completed

Eugene P Pendergrass, M D, of Philadelphia, will present a scientific exhibit with his paper, and there will be an extensive scientific exhibit presented in connection with the Bone Symposium

TRANSPORTATION

Fare and one-third (going and returning same route) of the *CURRENT ONE-WAY FIRST CLASS FARE* on the *CERTIFICATE PLAN* has been authorized by the Railroad

Passenger Associations of the United States and Canada These rates will apply to physicians (dependent members of their families) and guests, attending the meeting of the Radiological Society of North America in Detroit, Michigan, December 2-6, 1935

Be sure to ask for a *CERTIFICATE* when purchasing your *GOING TICKET* Be sure your *CERTIFICATE* is stamped with the same date as your *GOING TICKET* See that your ticket is stamped *DETROIT, MICHIGAN* Immediately upon arrival at the Convention present your *CERTIFICATE* to the endorsing officer, *CERTIFICATES* must be deposited at the Registration Bureau

SELLING DATES November 28 to December 4, inclusive *MORE DETAILED INFORMATION WILL BE PUBLISHED AT A LATER DATE WATCH FOR IT!*

COMMUNICATION

AUSTRALIAN AND NEW ZEALAND ASSOCIATION OF RADIOLOGY

This Association was registered by the Governor in council as a limited company on Feb 6, 1935 Branches are established in all States of Australia and New Zealand, with a central Federal Council controlling affairs in general Officers were elected on May 17, 1935, as follows *President*, Dr A T Nisbet (N S W), *Vice-president*, Dr H H Hewlett (Victoria), *Hon Treasurer*, Dr H R Sear (N S W), *Hon Secretary*, Dr H M Cutler (N S W) Additional members of Council Dr J G Edwards, Dr P Parkinson (N S W), Dr J C Clendinnen, Dr J O'Sullivan (Victoria), Dr Verco (South Australia), Dr W Holman (Tasmania), Dr V McDowall (B L W), Dr Clarke (Queensland), Dr Syme Johnson (W Australia), and Dr C C Anderson (New Zealand)

Now that Australia and New Zealand have an organized body composed of members interested in radiology and the allied sciences, it is hoped that intercommunication between this and other radiological societies may prove of mutual value Members of North American radiological societies are assured of assistance in whatever way members of the Association can serve them

Further information as to the aims of this Association may be learned upon applying to Dr H M Cutler, 135 MacQuarie St, Sydney, N S W, Australia

BOOK REVIEWS

L'ANNÉE ÉLECTRO-RADIOLOGIQUE MOREL-KAHN, with the collaboration of G BONTE, A DEVOIS, G DUCLAUX, T FAINSILBER, H FISCHGOLD, J GUILHEM, R HUMBERT, P MARQUES, W STROUZER, and L STUHL. Published by Masson et Cie, Paris, 1934. Paper, pages 232, illustrations 28. Price 40 francs.

Now that year books have become the fashion and that a year book on radiology has successfully been published in this country, it is not surprising to find the same idea being developed in other countries. This initial effort in France, under the editorship of Morel-Kahn, is an example in point.

The work is divided into four parts. In the first part are discussed the radiologic examinations of the breast, parathyroid osteosis, intracranial meningiomas, the fissural planes of the lung and the accessory pulmonary lobes, the technic of pulmonary radiography, intravenous urography, exploration of the cranial sinuses by the method of Proetz, kymography, cancer of the stomach, the gall bladder, and the digestive mucosa. In connection with each subject the newer methods are described and discussed. The second part, devoted to therapeutic radiology, presents and considers the treatment of lymphogranulomatosis, of inflammatory conditions, the Coutard method of fractional irradiation, the treatment of hyperthyroidism, radium treatment for cancer of the cervix, and roentgen therapy at voltages higher than 500 kilovolts. The third part includes a discussion of various electrotherapeutic methods including the use of high frequency currents, dielectrolysis, chronaxia and the new conception of thermal sensation, short wave diathermy, electrotherapy in gynecology, and ionization with histamine. The fourth part is devoted to a brief summary of the scientific program of the Annual Congress of the British Institute of Radiology (London, Dec 6, 1933), of the German Congress of Radiology (Bremen, May 9, 1933), comments on several Italian Congresses, on the Seventh Congress of the Nordic Association of Medical Radiology (Stockholm, June, 1933), of the Eighth Congress of the French Association of Gynecologists and Obstetricians (Paris, Oct., 1933), and of the Thirty third Congress of the French Association of Urology (Paris, Oct., 1933).

On the whole, the presentation of the dif-

ferent subjects is accurate and the discussions are lucid and fair. As a year book this is perhaps not as complete and thorough as it might be, but it is an excellent beginning and Morel-Kahn and his collaborators are to be congratulated on the preparation of this work.

THE 1934 YEAR BOOK OF RADIOLOGY. DIAGNOSIS, edited by CHARLES A. WATERS, M.D., Associate in Roentgenology, Johns Hopkins University, Assistant Visiting Roentgenologist, Johns Hopkins Hospital, THERAPEUTICS, edited by IRA I. KAPLAN, B.Sc., M.D., Director, Division of Cancer, Department of Hospitals, City of New York, Visiting Radiation Therapist, Bellevue Hospital, Director, New York City and Brooklyn Cancer Institutes, Associate Radium Therapist, Lenox Hill Hospital, Clinical Professor of Surgery, New York University and Bellevue Medical College. Published by The Year Book Publishers, Inc., 1934, Chicago, Illinois. A volume of 512 pages and 454 illustrations. Price, \$4.50.

This annual review of significant radiologic literature in its short period of existence has become a valuable addition to the library of every well-informed radiologist. Not only will a perusal of its pages emphasize the rapidly growing ramifications of this specialty but no serious-minded physician can read it without being fired with a certain amount of enthusiasm for the possibilities unfolded by the application of modern radiologic procedures.

"Radiologic literature during the past year has been lacking in original and enlightening contributions, probably as a reflection of disordered political and economic conditions throughout the world." "Especially in Germany, cancer work has been markedly disturbed and the regular contributions and highly valuable research work of old, experienced investigators have been interrupted because of their migration to new fields." All of this is reflected in the diminution in size of the present volume in contrast to its predecessors.

It is impossible to review the contents of a book of this nature with any sort of a fair appraisal of its contents. All phases of radiology, both diagnostic and therapeutic, are excellently surveyed, and the editorial comments concerning various articles enhance their value considerably. Students and experienced radiologists alike will find much of practical value in this volume. The price this year has been reduced.

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ADDISON'S DISEASE

Diagnostic Importance of Calcifications in the Suprarenals A Beutel Med Klin, Nov 2, 1934, 30, 1450 (Reprinted by permission from British Med Jour, Feb 23 1935, p 31 of Epitome of Current Medical Literature)

The author, who states that Addison's disease may be very difficult to diagnose without the help of x rays, describes three cases in which the diagnosis was confirmed by the finding of calcium deposits in the adrenals. In 80 per cent of cases the condition is due to tuberculosis of both adrenals but it is unknown in what percentage calcification takes place. Calcification of both adrenals is the rule, but Addison's disease may occur when only one adrenal is affected. Certain conditions must be borne in mind in the differential diagnosis: (1) calcification of the para aortic mesenteric lymph glands is seen as a crumbly mass arranged in rows, adrenal calcification is more flaky; (2) tuberculosis of the upper pole of the kidney, (3) pancreatic calculi, (4) calcification of the costal cartilages. The author recommends the taking of an x ray film in every suspected case of Addison's disease.

APPARATUS

The Technic of Colon Examinations by the Contrast Enema A Determann Röntgenpraxis May, 1935, 7, 329-331

During the examination of the colon with the barium-air contrast enema, the change of the tube for the barium enema and then air is often bothersome and the emptying of parts of the colon after the barium enema is often incomplete. The author describes an apparatus by means of which it is possible to inject alternately, a small amount of barium under varying pressure and again air without changing the enema tip or without having the patient expel part of the material. It is also possible to siphon out the enema through the same apparatus. In the average case, only little more than a pint of barium mixture is necessary for a complete examination of the colon.

HANS W HEFKE, M D

Speedier Production of the Finished Radiograph A E Barclay British Jour Radiol, June 1935, 8, 373-384

The author conducted considerable experimental work in an effort to speed up the production of x-ray films. Under experimental conditions he was able to completely process and dry a satisfactory film of the wrist, properly labeled, in 15 minutes. As a result of his studies he makes the following suggestions:

- (1) The developer must be fresh
- (2) The hypo should not be below 65 degrees F in temperature
- (3) The film should be left in the hypo only 30 seconds after it is apparently fixed
- (4) A series of small tanks, each section accommodating one film is suggested by the author
- (5) The importance of running water is stressed

(6) Four minutes of washing under the above conditions is considered sufficient

(7) Drying is accomplished by means of a rubber-rollered wringing machine which removes 33 per cent by weight of the water, with no damage to the emulsion of the film

(8) The film is further dried by means of dry, heated air from a blower

J N ANÉ M D

An Arrangement for Measuring Temperature in Short Wave Diathermy Kristian Overgaard Strahlentherapie 1935 53, 337, 338

The author describes a thermo-couple with cannula which may be introduced into the tissue for temperature measurements in ultra short wave therapy (4.5-30 meters). It permits a continuous recording of the temperature during treatment without introducing any of the well known errors.

ERNST A POHLE M D Ph D

An Automatic Filter Safety Device with Time Control Janker Strahlentherapie 1935, 52, 349-352

The author describes a rather complicated device which automatically shifts the proper filter into place and interrupts the treatment at the proper time. Details of the construction should be looked up in the original article. ERNST A POHLE M D Ph D

THE APPENDIX

Radiology of the Appendix (Appendiculography) Franklin G Wood British Med Jour March 30, 1935, No 3873 640-642

The author believes that the appendix can always be visualized and studied by means of the x ray unless the lumen of this organ is obliterated by disease or obstructed by fibrosis or adhesions. This study depends primarily upon careful roentgen technic. The author's technic consists in giving a preparation of barium with milk or cornflour at night and following this after an interval of three hours by a dose of magnesium sulphate, varied according to the requirements of the individual patient. Roentgenograms are obtained on the following morning, and are continued at such intervals as may appear necessary during the following days, until the cecum is entirely empty.

There is some difference in opinion regarding the normal appearance of the appendix. While there is no definite position for the normal appendix it is most frequently found medial to the cecum. It may point in any direction but it is believed that an appendix situated to the lateral side of the cecum is probably abnormal. When the appendix is completely filled the contour of the organ should be smooth in outline until it begins to empty which should occur at the same time that the cecum empties. Delay in emptying of the appendix over the 48-hour period is considered suggestive for appendicular pathology. The mobility of the appendix can be determined by fluoroscopic examination and if the organ is normal it should be

freely movable The presence of fecoliths may be detected by sharply defined and constant filling defects in the appendicular shadow

The radiological signs which are considered suggestive of a diseased appendix are as follows (1) dilatation of the lumen, (2) fixation of the appendix in one position, (3) delay in emptying, (4) clear-cut filling defects, and (5) non-filling after repeated examinations

J N ANÉ, M D

BIOLOGIC EFFECTS OF RADIATION

The Heat Effect of Short and Ultra short Electric Waves and Their Specific Action N N Malov Strahlentherapie, 1935, 53, 326-336

Some investigators have stated that ultra short electric waves have a specific effect on living cells The author carried out a series of experiments on fruit flies, using a circuit delivering 500 watts with a wave length of from 43 to 107.5 meters He comes to the conclusion that the death of the fruit flies in the condenser field is due to heat and that no marked difference could be found between ultra short and short waves Consequently the hypothesis of the so-called specific effect cannot be supported

ERNST A POHLE, M D Ph D

BLOOD CHANGES

The Effect of Roentgen Rays on the Transparency of the Barrier between Blood and Spinal Fluid A O Natansohn and S A Nikitin Strahlentherapie, 1935, 53, 296-307

A number of investigators have considered the possibility that the permeability of the barrier between blood and spinal fluid may be influenced by roentgen rays The authors studied this problem on 11 rats The entire back of each animal was exposed to roentgen rays (210 K V 23 cm F S D, 4 mm Al 1200 r) with a dose sufficient to produce shock The latter was overcome by irradiating the animals under ether anesthesia All tests were carried out according to a method described by Stern Gautier It appeared that the permeability of the barrier was not changed, particularly during the period of shock In the after period there was a definite increase in the permeability which is interpreted as a sign of injury to the cells carrying the barrier function Any therapeutic attempt to influence the permeability of the barrier should, therefore, be deferred until additional data are available

ERNST A POHLE M D Ph D

BONE DISEASES (DIAGNOSIS)

Typhoid Diseases of the Bones A M Rybak Roentgenpraxis June 1935 7, 361-368

The author's experience proves that typhoid fever may lead to disease of the bone in a fair percentage of cases His observations were made in Leningrad Osteomyelitis of the spine and long bones after typhoid recurrent fever and typhus is not at all rare in Russia

Roentgenograms show a characteristic appearance of post-typhoid spondylitis A narrowing or disappearance of the intervertebral disc areas of destruction in the vertebral bodies close to the disc absence of marked destruction and presence of bony bridges between the diseased vertebrae constitute a more or less typical syndrome

While the typhoid spondylitis may appear often after apparent recovery and even years afterwards, the osteitis typhosa is seen only during the acute phase of the disease The process is usually localized in the cortex and leads to periosteal reaction, it is, mostly, of small dimensions only and sometimes so localized that tangential roentgenograms are necessary to show it The lower extremities are much more often diseased than the upper Staphylococcal osteomyelitis can be differentiated by the deeper seat of the infection and involvement of the marrow and the much more frequent presence of sequestra A syphilitic osteitis may show the same appearance and must be excluded by history and blood-examination

HANS W HEFKE M D

CALCULI

Recurrent Urolithiasis Etiologic Factors and Clinical Management Linwood D Keyser Jour Am Med Assn, April 13 1935, 104, 1299-1305

Experimentally the production of calculi in laboratory animals may be recounted in the following ways (1) By the feeding of oxamide (2) by producing an artificial excessive excretion of calcium oxalate, (3) by excessive doses of parathyroid extract and of viosterol, (4) the formation of uric acid calculi in animals with Eck fistulas, (5) by feeding diets deficient in vitamin A (6) by infection with urea splitting streptococci, staphylococci and *B. proteus-ammoniae*, (7) by the incrustation of organic or inorganic foreign bodies in the presence of infection

The first four of these methods imply an aseptic metabolic disturbance associated with excessive excretion of urinary crystalloids The role of infection in the sixth and seventh methods of experimental calculus production is obvious That the infection is specific is attested by the fact that organisms successfully used by different observers were isolated from the teeth, tonsils or urine of patients afflicted with active stone formation and that the use of strains of similar organisms from other sources gave negative results

The author feels there is much to be learned before a vitamin deficient diet can be accepted as a cause of stone in the usual American patient From the clinical side, evidence for the two types of calculosis, namely hyperexcretory and infectious, is abundant Likewise the clinical evidence for calculosis from infection with alkaline urea splitting specific streptococci, staphylococci and *Proteus* organisms is abundant

Experimental evidence is now sufficiently correlated with clinical data to justify the acceptance of at least two mechanisms of stone formation as reasonably well established facts first, metabolic hyperexcretion

of crystalloids and, second, infection with biologically specific stone forming bacteria. Doubtless other mechanisms will also be shown to be at fault, each of them acting in some way to upset the solvent properties of the urinary colloids.

Measures to be employed in preventive therapy against recurrence include removal of all stones as far as practicable by surgery or cystoscopy, avoidance of exposure of suture material to the urinary stream and insurance of proper urinary drainage, dietary regulation with regard to the intake of purines, ovalates or calcium and phosphorus, a high intake of vitamin A, and every effort to correct the metabolic disturbance present. An intensive and persistent effort to eradicate or to reduce to a minimum the infection should be made. Finally, the reaction of the urine should be shifted to the opposite of that which is ideal for deposition of stone.

CHARLES G. SUTHERLAND, M.D.

The Present Conception of Renal Lithiasis. Virgil S. Counseller and James T. Priestley. *Jour Am Med Assn*, April 13, 1935, 104, 1309-1313.

The authors review recent as well as some of the earlier work on the formation of stones, the general surgical principles involved in present day treatment, and, finally, post operative and prophylactic treatment of this condition.

The theory of infection, sponsored chiefly by Rosenow and his co-workers, has many adherents. Hager and Magath isolated from the urine of patients afflicted with alkaline encrusted cystitis an organism closely related to the *Salmonella Proteus ammoniae*. This organism is regarded as a secondary invader favoring the precipitation of urinary salts. C. H. Mayo contends that the development of stones requires the presence of two types of bacteria, one of these produces hematogenous infection whereas the other may come from a local focus. There is no doubt that stasis and infection are contributory causes. Infection is associated with faulty drainage in most instances. There is some evidence of a relationship between a deficiency of vitamin A and the formation of urinary calculi. Both crystalloids and colloids are essential in the production of stone and it is incorrect to assign a principal part to either of them. When crystalloids are abnormally excessive, colloids may be unable to retain them in solution thereby resulting in formation of calculi. Studies on the parathyroid bodies recently have served to increase the probability that renal lithiasis is in some fashion linked to disturbances in metabolism.

The general surgical considerations, recurrence and prophylactic care are discussed in detail.

CHARLES G. SUTHERLAND, M.D.

Production and Solution of Urinary Calculi. Experimental and Clinical Studies. Charles C. Higgins. *Jour Am Med Assn*, April 13, 1935, 104, 1296-1299.

In experimental investigation this author found that urinary calculi develop in albino rats sustained on a diet deficient in vitamin A and alkaluria and keratiniza-

tion of the epithelium of the urinary tract were constant observations. Infection of the urinary tract was frequent in the later stages of the experiment. The calculi were composed chiefly of calcium phosphate. Addition of vitamin A caused disintegration and solution of the calculi experimentally produced in rats. The chemical conditions necessary for the formation of calculi were produced by vitamin A deficiency. He suggested an acid ash diet high in vitamins as a prophylactic measure to prevent the recurrence of calculi in patients who had urinary lithiasis and the rôle of vitamin A in the diet to prevent primary calculous disease was important. A high vitamin, acid ash diet produced a decrease in size or total disappearance of renal calculi in patients refusing surgical intervention or in whom operation was not indicated. In 18 collected cases in which the high vitamin, acid ash diet was used the renal calculi underwent solution according to roentgenographic evidence.

CHARLES G. SUTHERLAND, M.D.

CANCER (THERAPY)

Primary Rectal Carcinoma under Radiation Treatment. A Statistical Review of 500 Cases. Harry H. Bowing and Robert E. Fricke. *Am Jour Roentgenol* and *Rad Ther*, November, 1934, 32, 635-645.

During the period from 1915 to 1931 there were over 800 cases of carcinoma of the anus, rectum and rectosigmoid treated with radium and x-rays either alone or in combination with surgery at the Mayo Clinic. The results of 500 cases were analyzed in the article. The average age was 53 years. Of the group, 69 per cent were males and 31 per cent females.

Those lesions arising low in the rectum are more suitable to radiation therapy than those in the rectosigmoid. The cases were classified as operable, borderline inoperable, recurrent, and modified the latter group representing those cases having already received treatment to the primary lesion elsewhere.

The diagnosis was as a rule readily established and was confirmed by history and digital and proctoscopic examination. Biopsy is necessary for grading purposes for determining the best method of attack and the probable prognosis. Of the cases, 64 per cent had biopsy study, 28 per cent being papillary carcinomas, 78 per cent adenocarcinomas, 15 per cent colloid carcinomas, 34 per cent squamous-cell epitheliomas and 0.6 per cent melano-epitheliomas. Classified according to Broders' grouping, 17 per cent were Grade 1, 52 per cent Grade 2, 18 per cent Grade 3 and 12 per cent Grade 4. Six of the cases showed primary carcinomas in other parts of the body.

There is relatively small risk in radiation therapy as compared to the surgical risk, the radium puncture procedure contributing the element of risk in radiating the patient. In this group, 86 per cent received some type of surgical procedure while 96 per cent were given radium therapy. The writers feel that it is entirely possible to treat selected cases adequately without doing colostomy.

The authors conclude by stating that while surgical intervention should be the first consideration, pre-operative radium therapy should receive special consideration, and in those lesions showing a high grade of malignancy post-operative radium therapy should also be used

J E HABBE M D

The Treatment of Cancer of the Pharynx, Tonsil and Extrinsic Larynx by Divided Doses of External Radiation Hayes E Martin and Robert F McNattin *Am Jour Roentgenol and Rad Ther* December, 1934, 32, 717-729

When radiation is administered in multiple divided doses over an extended though definitely limited period of time the differential effect on pathologic (neoplastic) and normal tissues is increased. To effect complete sterilization of tumors the quantity of radiation administered must be close to the local and general tolerance. While the writers believe in the Coutard method in principle (large total dosage of from 1,500 to 3,000 r per field, administered at frequent intervals over a limited number of days—15 to 30), they are of the opinion that it is not essential for successful handling of cases to adhere to any single technic of treatment factors.

Sources of radiation utilized in the group of cases herein reported included (1) x-rays at 200 K.V.P. 50 to 65 cm distance, filter 0.5 mm copper and 2.5 mm aluminum, 4 or 30 ma current, (2) x-rays at 700 K.V.P., 60 cm distance filter 5 mm copper (equivalent) 5 to 6 ma current and (3) radium element pack, filter 2 mm lead (equivalent) 10 to 15 cm distance, applicator portal 10 cm in diameter. For the x-radiation the output at 60 cm using 30 ma and 200 K.V. is 40 r per minute, with 4 ma, at 60 cm, the output is 8 r per minute at 60 centimeters. Smaller sized skin portals (about 7 or 8 cm in diameter) are considered preferable to the larger portal utilizing 100 to 150 sq cm of skin surface, hence in most of the cases smaller round portals are utilized with the aid of a set of metal cones varying from 7 to 15 cm in diameter.

For most pharyngeal and laryngeal tumors two portals are used one for each side of the neck.

In lesions of the posterior nasal pharynx four portals are used, to include the neck metastases. In cancer of the anterior floor of the mouth three portals may be used. In some cases of tonsillar or upper pharyngeal wall carcinoma a third portal is utilized through the open mouth. The maxillary antrum is usually radiated through one portal although in some cases two contiguous square portals are used.

As has been reported by Coutard the prognosis is better in females than in males and in older patients than in younger. The histological type of the tumor offers less of prognostic value than might be supposed. In the 140 cases included in the report about 60 per cent were considered radioresistant (squamous or epidermoid carcinoma Grades I and II), the remaining 40 per cent were anaplastic and presumably radiosensitive (lympho-epithelioma transitional-cell carcinoma epidermoid carcinoma Grades III and IV and

lymphosarcoma). In the unsuccessful group (numbering 110), 75 per cent were adult type lesions and 25 per cent anaplastic. In the successful group, 55 per cent were adult lesions and 45 per cent anaplastic. Regression of the tumor may begin as early as the fourth or fifth day although at times it may not be apparent until after several weeks. If regression is not complete by one month after beginning of treatment, one should consider the advisability of the insertion of radon seeds.

Early in the course of treatment, mouth irrigations every two hours with a solution of warm sodium bicarbonate are advised. For the skin changes, when dry, applications of mineral oil are used, when moist, single layers of gauze impregnated with boric acid ointment are applied. For dysphagia, nasal feeding may at times solve the difficulty, although at times gastrostomy is necessary. Tracheotomy had better be performed prior to starting radiation than during the course of treatment and should be done as low down as possible.

In the cases treated in 1931 the average dose in the successful case was 2,400 to each of two portals in 14 days. In 1932, the average successful dose had been increased to from 3,000 to 3,500 r to each portal in from 20 to 25 days.

Prognosis for successful therapy by anatomical classification was tonsil, 31 per cent, nasopharynx 33 per cent, pharynx, 25 per cent and extrinsic larynx 19 per cent. In the successful group, only 40 per cent showed metastases on admission, in the unsuccessful group 80 per cent showed metastases. The report includes the results to date of 140 cases treated during 1931 and 1932.

J E HABBE M D

Radiation Treatment of Carcinoma of the Cervix William P Healy and A Norman Arneson *Am Jour Roentgenol and Rad Ther*, November, 1934 32, 646-653

This paper is a preliminary report on 26 cases of cervical cancer, using a new technic of external roentgen ray irradiation the purpose being to increase the effective irradiation to the pelvic field about the cervix.

In early cases in which the disease is limited to the vaginal cervix one may expect 50 to 60 per cent of five-year cures with radium alone. However such favorable cases form a very small group of the total number coming for treatment of this condition, since about 75 to 80 per cent of the patients already have parametrial involvement and intrapelvic metastases in addition to greatly enlarged and often ulcerated infected cervixes.

The advantages of giving the external radiation first in the average case are that one will thereby diminish the discharge and bleeding and reduce the gross size of the primary lesion by causing superficial infected and friable tissues to disappear. Under these circumstances the cancer field is much better able to react to the application of radium and usually both local and constitutional reactions to the introduction of radium are less severe.

In past years the routine pelvic cycle employed at Memorial Hospital consisted of 700 r to each of four

fields, given within a week and administered with the following factors 50 cm target skin distance, 0.5 mm of copper 2 mm of aluminum 200 K V peak 30 ma, 10 cm \times 15 cm field

The change in technic of external irradiation exists in increasing the target-skin distance from 50 cm to 70 cm in order to increase the depth dose, and to increase the number of r to each field from 700 to 2,000 to 2,400, treatments of 200 r being given to each of two fields daily until each skin area has received the total dosage planned, which requires from 20 to 30 days

Radium therapy follows and consists of 1,500 mc-hr in the vaginal canal against the cervical lesion, using filtration of 2 mm of brass, immediately after which two radon capsules are placed in the cervical and uterine canal for a total of 3,000 mc-hr, using a filter of 0.5 mm of gold and 2 mm black rubber

In the present series reported there were 25 squamous epidermoid carcinomas and one adenocarcinoma all but one of which were clinically advanced the disease having extended well beyond the cervix

When an individual is given 2,400 r to each field, as indicated above, approximately 10 per cent of the cases will show no skin reaction 80 per cent will show a very moderate reaction equivalent to a little more than a threshold erythema, and in 10 per cent there will be a fairly marked skin reaction indicated by peeling

Biopsies were taken from 17 cases at 3- to 5 day intervals during the course of treatment to verify histologically any clinical evidence of regression Some cases showed complete primary healing from the external radiation alone, while others did not and it was obvious that permanent healing could not be expected from this amount of external irradiation alone

In the first few days after beginning the external irradiation there were noted histologically plasma cell infiltration and diminution of inflammation the tumor cells showing swelling and becoming acidophilic In the second week the cells became vacuolated and showed degenerated, hydropic nuclei The cells developed an opaque appearance resembling ground glass The blood vessels showed beginning arteritis and thrombosis By the third week, in many specimens, very little tumor could be found and fibrosis was marked Radiation damage to the tumor was obviously more marked than in control cases treated by the old technic of 700 r to each field All of the patients stood the treatment remarkably well there being little or no bladder or rectal distress The bulk of the parametrial region receives five threshold erythema doses directly adjacent to the uterus or three erythema doses 10 to 11 cm from the cervical canal, by such external irradiation

J E HABBE, M D

The Treatment of Malignant Neoplasms with the Concentrated Fractional Dose Method with Short F S D H Chaoul *Strahlentherapie* 1935 53, 202-209

In a previous article (*Strahlentherapie* 1933 48, 31) the author has already given a preliminary report as to the results obtained by his method of roentgen irradiation with short F S D in the treatment of super-

ficial malignancies He explains that he attempted to parallel the technic of application as much as possible to that of radium Percentage depth dose and isodose curves for small areas not exceeding 20 sq cm and a potential of 60 K V, with 0.2 mm Cu at 5 cm F S D are given For deeper infiltrating neoplasms 160 K V 0.5 mm Cu and 10 cm F S D may be advantageous Daily surface doses of from 300 to 400 r, applied at a rate of from 100 to 150 r per minute and total doses of from 4,000 to 8,000 r in from two to four weeks have been given Careful daily examination of the skin is imperative in order to discontinue treatment before producing irreparable changes Four tables are appended showing preliminary results over a period of from one to three years In carcinoma of the skin and melanoma, the number of successfully treated cases reached 96.2 per cent, in carcinoma of the lip, 90.5 per cent, in intra oral carcinoma, 50 per cent, and in carcinoma of the parotid, thyroid breast and rectum 59.1 per cent

ERNST A. POHLE, M D, Ph D

The Care and Treatment of Chronic Cancer Cases Ira I Kaplan *Am Jour Roentgenol and Rad Ther*, December 1934, 32, 740-742

Kaplan emphasizes the need in large centers such as New York City where bed capacity for cancer cases is limited of carefully classifying all individuals with malignant lesions as to their need of hospitalization and active cancer therapy, either radiation or surgical or combined and as cases requiring only custodial care or home nursing, supplemented by periodic visits of a nurse or social service worker attached to the hospital

Hospitalization is needed only in (1) cases receiving active surgical treatment, (2) cases receiving intense irradiation, (3) cases receiving palliative treatment at periodic intervals, (4) cases receiving continued treatment because of resistance and growth of the disease requiring expert nursing and medical care and (5) cases requiring surgical or medical treatment subsequent to intense radiation

The author points out that in certain elderly women who have had nodular scirrhous breast tumors existent for years neither surgical nor radiation treatment may be either advisable or effective and that such cases may well be left alone Again certain individuals often past the age of 70 manifest symptoms of malignancy such as bleeding from the cervix mouth nose or rectum Low grade malignant cases such as these are best handled by topical applications of radium only for healing the local lesion since death usually ensues from ordinary old age causes rather than from such malignancy

Since so much real benefit can be accomplished from co-ordinated surgical and radiation therapy in so many cancer cases (according to Forssell at least 44 per cent) it is essential in institutions where the bed capacity for cancer cases is limited that cases be carefully selected for hospitalization according to their ability to be benefited by such a procedure

J E HABBE, M D

The Treatment of Skin Cancer with the Concentrated Fractional Dose Method (Chaoul) Gerhard Liebmann *Strahlentherapie*, 1935, 53, 217-224

The author has used the method of Chaoul (roentgen therapy at 60 K V, 0.2 mm Cu, 5 cm F S D) in 23 cases of skin cancer. His technic was slightly modified in order to adapt it to the available apparatus. The F S D amounted to 11 cm, with single doses of 300-500 r at 66 K V and 2 mm Al, rate of application 60 to 100 r per minute. The single doses were repeated at intervals of from 1 to 8 days, the total dose varied from 4 to 5,000 r with a field not exceeding 20 square centimeters. In 96.4 per cent, including inoperable skin carcinomas, good results were obtained. There is one advantage of the method which the author considers—the fact that the treatment may be repeated without danger after eight weeks.

ERNST A. POHLE, M D, Ph D

The Development of Radiation Therapy of Uterine Carcinoma during the Last Two Decades Felix Gal *Strahlentherapie*, 1935, 53, 231-246

This is a statistical study which does not lend itself well to abstracting and the reader is therefore referred to the original. The author reviews a total of 2,461 patients with uterine carcinoma treated by irradiation. In 1,243 cases the treatment plan could be carried out completely, and 827 women were traced, of whom 102 remained well for five years and longer. The cases include carcinoma of the cervix, fundus, vagina and vulva.

The author concludes, after comparing the results obtained in the various periods, that undoubtedly great progress has been made in radiation therapy of malignant neoplasms in the female genital organs.

ERNST A. POHLE, M D, Ph D

Transcutaneous Curiotherapy of Carcinoma of the Tonsils Lucien Mallet *Strahlentherapie*, 1935, 53, 54-61

In the author's experience about 20 per cent of all intra-oral tumors arose from the tonsils. During the period from 1927 to 1932 he treated five sarcomas of the tonsils: four were still alive in July, 1934 and without recurrence one seven years, one four years and six months, one two years and three months and one, one year and two months after treatment. Brief histories are given with data on the treatment technic. During the period from 1929 to 1932, 10 cases with epithelioma of the tonsils were treated. Two could not be traced, one lived two years and eight months, one eleven, one five, and one, six months after the treatment. Four are still alive without recurrence for two years and five months, two years and two months, two years and one year and eight months, respectively. The histories of eight of these cases are briefly quoted. The treatment must be protracted, a few sources of radiant energy should be used at high F S D. The dose in the diseased area should amount to from 2 to 2.5 D per day. Irradiation should continue without interruption day and night for from 20 to 25 days, until a total dose in the tumor of about 50 D has been reached.

This corresponds to an x-ray dose of about 2,200 r. This technic permits the homogeneous irradiation of all adjacent lymphatics. The author recommends the exposure of both cervical regions in tumors of the tonsil as a rule, six applicators on each side at 6 cm F S D suffice.

In his experience the histologic structure of the tumor had little influence on the prognosis. In highly infected and extensive tumors, in which glandular enlargement is due to inflammation as well as to carcinomatous infiltration, the results were poor. As a rule one may say that glandular enlargement one month after irradiation or induration in the tonsillar area indicates a recurrence. In such cases it will be best to remove all growths surgically and then give irradiation post-operatively. The author has seen very little systemic reaction in radiation therapy of intra-oral tumors. Carcinoma of the tongue and hypopharynx are less sensitive than carcinoma of the tonsils.

ERNST A. POHLE, M D, Ph D

My Method for Continuous Irradiation of Carcinoma with Roentgen Rays Super-telereontgen Therapy Gian G. Palmieri *Strahlentherapie*, 1935, 53, 247-260

The author describes an apparatus which he designed for roentgen irradiation at long F S D with continuous exposure of the entire body. It is housed in a special three-story building. The first and third floors contain one x-ray tube and in the second story are the treatment cubicles. The transformer is also housed in the first floor. Technic: 170-185 K V, 2-4 ma, 0.065-0.265 r per minute, treatment time 2-4½ hours, dose per sitting 60-200 r. The entire arrangement corresponds to the method developed by the late Dr. Heublein of the Memorial Hospital, New York City.

ERNST A. POHLE, M D, Ph D

CONTRAST MEDIA

A Note on Peroral Pyelography Hugh Morris *British Jour. Radiol.*, June, 1935, 8, 393-395

Following the description by Jacques and Swick of the use of sodium ortho hippurate or 'hippuran' by oral administration for the study of the urinary tract, the author discusses his experience with this method.

The technic of the method consists in the oral administration of 12 grams of hippuran dissolved in 75 cc of simple syrup in the case of adults. Children under 13 years of age are given only 10 grams of the salt. Forty-five minutes after the administration of the solution the patient is made to lie on the Potter-Bucky table and compression is applied over the lower ends of the ureters. This compression is not relaxed until the examination is completed. Films are taken at 60, 90, 120, and 150 minutes after the ingestion of hippuran, then ureteric compression is relaxed and a bladder film is made.

The oral method is of value in those cases in which intravenous administration of the opaque medium is considered impracticable or inadvisable. One disadvantage of the method is the uncertain absorption from the gastro-intestinal tract in some cases, which

prevents the method from being used as a means of estimating renal function. Another disadvantage is that in a small but busy x-ray department the Potter-Bucky table is held up for a considerable period of time by each examination.

J N ANÈ M D

THE CRANIUM

Technic and Dosage in Roentgen Therapy of Intracranial Disease. Max Sgalitzer. *Strahlentherapie*, 1935 53, 3-24

The author advocates the use of several large fields of entry (approximately 6×11 cm) in the treatment of many intracranial diseases. Four fields are recommended in hydrocephalus; many cases of severe headache, epilepsy, and inflammatory diseases of the brain. Small fields are indicated for intrasellar tumors in the absence of hydrocephalus. The treatment should always be given with the fractional dose method in order to avoid severe reactions. He never applies more than one field per day with a maximum dose of 150 r through 0.5 mm Zn + 1.0 mm Al at 170-180 K V and 2-3 milliamperes. The total dose depends on the location and size of the tumor, its nature, the differentiation of its cells, age of the patient, the presence or absence of hydrocephalus, the intracranial pressure, and also if surgery has preceded radiation or not. The author usually gives a test exposure with a maximum of 50 r in order to determine the reaction of the patient. The entire treatment takes from two to three weeks, and the total dose per area should not exceed 600 r except in very exceptional cases. Post-operative irradiation is particularly indicated in incompletely removed gliomas and sarcomas. In conclusion, the author states that a combination of surgery and radiation therapy will give the best results in the treatment of tumors of the brain.

ERNST A. POHLE, M D Ph D

DERMATOLOGY

Radiotherapy of the Sympathetic System in General Medicine. Its Application to Dermatology. J Goun and A. Bienvenue. *Rev d'Actinol et de Physiothér*, September-October, 1934 10, 388-411 (Reprinted by permission from *British Med Jour*, March 2 1935, p 37 of *Epitome of Current Medical Literature*.)

The authors find that radiation of the sympathetic nervous system has a definite value in general medicine with special application to dermatology. It evokes nervous, glandular, and humoral responses in a similar way to those induced by surgery of the sympathetic system, shock therapy, and desensitization. The induced leukocytosis is of value in the treatment of suppurations and infective dermatoses, while the local trophic and circulatory effects are useful in other diseases of the skin. In psoriasis, however, little benefit is obtained other than results from the amelioration of an accompanying pruritus or, in children, the arrest of the early stages. In asthma associated with prurigo, however, quick relief results after a preliminary reaction. The method can also be employed in syphilis and tuberculosis in association with the other forms of

specific therapy, the effects of which it augments. The x-rays have to be focused on different parts of the body to obtain the various general results, and these areas are defined by the authors. They conclude that this form of treatment has great possibilities, but the polymorphic nature of the body's response has to be clearly realized in order to apply it successfully.

DIATHERMY

Diathermy and Regeneration of Bone. E. David Wemberg and Grant E. Ward. *Arch Surg*, June 1934 28, 1121-1129

The apparatus used in this series of experiments consisted of a spark gap generator, the maximum capacity of which was approximately 770 watts. The milliamperage employed in each experiment depended on the size of the forelegs of the animal used and as a rule varied from 250 to 350 milliamperes. In smaller animals the milliamperage required to raise the temperature of the skin to tolerance was about 200, in larger ones 400 or 500 milliamperes was occasionally demanded. The average time of application was 35 minutes per treatment.

The animals used in all experiments were healthy normal dogs. The forelegs were chosen, in which the bones were more easily accessible and the experiments better controlled. The method of traumatizing the bone was that of boring a small hole $1/8$ inch in diameter through the large bone of the foreleg. This was done under general anesthesia with strict surgical asepsis. The holes were drilled as nearly alike as possible and in corresponding positions in each leg. The bone in the control (right) leg was then sutured immediately. Into the hole in the left leg a small clinical thermometer was inserted and another was placed in the surrounding muscle. In a few instances a third thermometer beneath the skin or between the diathermy electrode and the skin, indicated approximate subcutaneous or cutaneous temperatures. The edges of the skin and periosteum were brought together with interrupted black silk sutures while the thermometers remained in place. Sterilized diathermy electrodes consisting of rubber sponges surrounded by flexible brass mesh were then applied on each side of the left leg opposite the site of the incision. These were held in place by suitable sterilized wooden clamps. Sterile high frequency cords connected the electrodes to the generating apparatus.

After several trials to standardize technic it was found that the temperature in the bone could be raised to 101 or 102° F without injuring the skin. In a few cases in which the temperature of the bone was raised to 105 or 106° F secondary sloughing of the skin occurred. Treatments were repeated each day for from one to four weeks, the same settings on the apparatus and the same amperage as were determined on the day of the operation being used. At the end of the various periods of treatment the dogs were killed for gross and microscopic studies of both the treated and the untreated bones.

During the immediate post-operative treatment with diathermy, attention was attracted by the variation of the bleeding in the open wounds. Shortly after turn

ing on the current there was a free flow of blood. As soon as the heat was discontinued and the leg allowed to cool a little, the bleeding stopped. This occurred with such regularity that it caused the authors to conclude that the heat, or perhaps some other electromagnetic effect of the diathermy, dilated the blood vessels, allowing free escape of blood into the wound.

At the end of one week microscopic sections revealed the hole in the treated leg to be filled with vascularized connective tissue, a few degenerated red blood cells, and a small amount of bone dust. An attempt at formation of new bone was evident arising from the cut edges of the endosteum. The endosteum in the neighborhood of the hole showed a marked proliferation of osteoid tissue extending down into the marrow cavity, and the marrow cavity near the hole was filled with young fibrous connective tissue which was highly vascularized. In the control leg the hole was filled with a partially organized blood clot, fibrous connective tissue, degenerated red blood cells, and bone dust, undergoing partial absorption. The cut edges of the endosteum were lined by fragmented bone with the bone cells missing. At the end of two weeks the treated leg showed marked formation of bone arising from periosteum, endosteum, and the cut edges of the compacta. There was also evidence of formation of new bone in the marrow with consequent narrowing of the medullary cavity. In the control leg there was some periosteal new bone in the immediate neighborhood of the hole with some osteoid tissue but no bone. In three weeks the treated leg showed a decided advance in the periosteal and endosteal formation of new bone. The cut edges of the endosteum were lined with osteoblasts. There was marked proliferation of bone in the medullary cavity so that it was almost filled. In the control leg there was no periosteal new bone formation and only a small amount of endosteal new bone noted. The medullary cavity was far from being completely filled with bone. In four weeks the treated leg revealed marked new periosteal bone. The hole was completely filled with a compact type of bone (not the young lamellar type) and looked like old cortical bone, except for an increase in the haversian canals. In the control leg there was little or no periosteal new bone and the hole was filled with a lamellar type of bone so that it was not yet healed.

ANDREW H. DOWDY, M.D.

DOSAGE

Dosage of Gamma Rays in r units. J. Murdoch and E. Stahel. *Strahlentherapie* 1935 53, 102-118.

The authors found that 1 mg of radium filtered through 10 mm Pt delivers 7.62 r per hour at 1 cm distance. The respective value for a filter of 0.5 mm Pt is 8.11 r per hour. The measurement method is described in detail. An isodose chart with distribution of radiant energy in roentgens is shown. The energy absorbed per cc of water was determined by measurements in roentgens and by calculation of the gamma rays of radium. It appears that 1 r corresponds to 100 erg per cc of water (absorbed energy). It was also found that ionization chambers with light atomic wall

material permit the measurement of radium doses in roentgens. A few therapeutic doses used during the last six years are also quoted. A continuous exposure with 2 or 3 r per minute will produce an erythema on the skin after 2,300 r and a radio-epidermitis after from 3,500 to 4,000 r. Reduction of the intensity to 0.5 r per minute permits an increase in the dose to 5,000 r without producing a marked reaction.

ERNST A. POHLE, M.D., Ph.D.

The Distribution of Roentgen Rays within the Human Body. Edith H. Qumby, Murray M. Copeland, and Robert C. Woods. *Am Jour Roentgenol and Rad Ther* October 1934 32, 534-551.

Surface and depth doses delivered in various regions of the human body were measured in a cadaver and compared with those obtained in a water phantom, for 200 K V roentgen rays, 700 K V roentgen rays, and gamma rays. For 200 K V roentgen rays, comparisons were also made with surface and depth doses measured in the pelvis of living individuals.

It was found that for all parts of the body except the chest and intra-oral region surface and depth dose values obtained by measurements in a water phantom may be used as a satisfactory approximation to the true values in radiation therapy.

For intra-oral and thoracic regions, which varied from the phantom readings, correction curves were presented in the article.

S. M. ATKINS, M.D.

Coutard Roentgen Treatment of Malignant Tumors. Jens Nielsen. *Strahlentherapie*, 1935 53, 25-53.

The author discusses at length the principles of the Coutard method and analyzes the approach to the individual case. He warns against a schematic procedure and emphasizes the necessity of individualization in the use of this method. By the proper use of the time factor, local and systemic injuries may be avoided. Every patient should be carefully examined daily during the entire treatment period. If a residual tumor is found radium implantation and electrocoagulation are indicated for its removal. The author believes it is quite possible that the elective effect of roentgen rays may be better with potentials above 200 K V.

ERNST A. POHLE, M.D., Ph.D.

Percentage Depth Dose and Treatment Times for Various Potentials and Filters. J. Žakovský. *Strahlentherapie*, 1935 53, 125-133.

The author undertook a series of ionization measurements in order to analyze the relationship between tube potential, filters, percentage depth dose, and treatment time. He showed that for every tube potential the percentage depth dose has a maximum for a definite optimal filter thickness. If this filter thickness is increased there is a slight increase in the percentage depth dose. However, the increase in treatment time is too high to be economical; it is better to increase the focal skin distance. He gives a table in the paper which per-

units the selection of the most economical treatment conditions

ERNST A. POHLE, M.D., Ph.D.

Comparison of the Roentgen and Radium Spectrum from the Standpoint of the Practical Radiation Therapist. R. R. Rathbone. *Am Jour Roentgenol and Rad Ther*, December, 1934, 32, 808-809.

In this brief article the writer includes a graphic chart showing a comparison of roentgen and radium spectra using various kilovoltages and various filters and indicates the wave length in Angstroms resulting therefrom.

By knowing the peak kilovoltage and the filter employed one may determine the maximum and minimum wave lengths being used. For example, at 200 K.V.P., with 0.5 mm copper filter the maximum and minimum wave lengths are 0.46 Å and 0.06 Å respectively.

J. E. HABBE, M.D.

A More General Definition of the Roentgen ray Dose. W. R. Johner. *Strahlentherapie*, 1935, 53, 119-124.

After a brief discussion of the reasons which lead to the choice of ionization in air as a measuring method for the roentgen ray dose, the author offers the following revised definition of the roentgen unit. The roentgen ray dose is that amount of roentgen energy which is being absorbed at a certain place per mass unit. It should be measured by a small air-walled ionization chamber.

ERNST A. POHLE, M.D., Ph.D.

The Determination of the Dose in Roentgen Therapy. Ernst Otto. *Strahlentherapie*, 1935, 53, 350, 351.

The author has developed a chart which permits the determination of the treatment time for a combination of potentials, filters, and F.S.D. If there should be sufficient call for these charts, the publishers of 'Strahlentherapie' will have them printed.

ERNST A. POHLE, M.D., Ph.D.

ENCEPHALOGRAPHY

Encephalography. Karl Kornblum and Francis C. Grant. *Am Jour Roentgenol and Rad Ther*, September 1934, 32, 311-316.

Encephalography demands an exact, careful film examination, complete drainage of all the fluid (the method does not matter), and extreme care before a diagnosis of disease is made.

Ventricular distortion, marked generalized or asymmetrical atrophy, or arachnitis in the subarachnoid spaces may be easily recognized, but in the finer diffuse changes, mild or moderate atrophy, one must remember that the variation may be a normal one.

S. M. ATKINS, M.D.

Encephalography in Children. A. Earl Walker. *Am Jour Roentgenol and Rad Ther*, October, 1934, 32, 437-456.

In childhood, with the exemption of the acute inflammations of the central nervous system neoplasms are the most common cause of increased intracranial

tension. Of these neoplasms, 60 to 70 per cent are in the posterior fossa and, therefore, encephalography is contra indicated and even when performed is in most cases not satisfactory. For these, ventriculography is indicated. Encephalography is indicated in every stationary cerebral lesion after other methods have failed to establish definitely the diagnosis.

Many methods have been advanced by various operators for the procedure. Some remove all the fluid and others do not. The air introduced also varies from the same amount of fluid removed to as much as 30 cc more. Within eight hours of the procedure the majority of patients show a temperature rise to 101-103°F, a leukocytosis of 15,000 to 25,000, albumin and blood in the urine, and marked increase in the cells in the spinal fluid. Vomiting and headache also occur, as well as stiff neck. The blood pressure, pulse respiration, and spinal fluid pressure are normal.

The value of this procedure was illustrated in cases of mental retardation, cerebral infantile palsies, special types of idiocy, convulsive states, degenerative diseases and sequelae of cerebral trauma.

S. M. ATKINS, M.D.

ENDOCRINE GLANDS

A Discussion of General Roentgen Biology, and of the Endocrine System in Particular. Bruno Faccini. *Arch di Radiol*, Sept.-Oct., 1934, 10, 532-552.

This is a short, non technical review of the effects of radiation on various normal tissues of the body, and a discussion of the effects of radiating endocrine glands.

E. T. LEDDY, M.D.

THE ESOPHAGUS

Radiation Therapy of Carcinoma of the Esophagus. Rudolf Hummel. *Strahlentherapie*, 1935, 53, 225-230.

During 1922-1934, 72 cases with carcinoma of the esophagus were treated in the author's clinic by x-radiation. Technic during the last four years: 180 K.V. 0.5 mm Cu + 3 mm Al. 30 cm F.S.D. two sittings per day, 165 r (in air) per field for 18 week days. A skin erythema is produced with 170 K.V. 3 ma., 2 mm Cu + 1.0 mm Al at 70 cm F.S.D. in 390 minutes. In addition radium is inserted in a rubber tube in front of the fluoroscopic screen. From 280 to 300 mgh are given daily, with a total dose of from 1,500 to 2,000 mgh, an interval of from five to six days between sittings, filter 0.5 mm platinum-iridium, length of screen 2 cm, strength 10 mg each. If the sitting extends seven hours patients usually complain. Gastrostomy is done only in cases in which insufficient nourishment can be obtained by mouth.

Eleven cases received roentgen therapy only, 19 were treated with the older methods, eleven were treated by radium only. The results in all these groups were not very encouraging. Twenty-nine patients received treatment according to the method described above. In 10 cases gastrostomy had to be performed. Nine patients were still alive after 6 months, five after 9 months, three after 12 months, and one after 18 months. The author concludes that, even with the

combined roentgen and radium therapy, only temporary results are to be expected

ERNST A. POHLE, M D, Ph D

FOREIGN BODIES

Wandering of a Swallowed Needle Case Report Ludwig Bayer and Klaus Berg *Röntgenpraxis*, June, 1935 7, 380-381

How much—and if—foreign bodies may change their position appreciably is still a matter of dispute. The authors' patient was admitted for an acute disease of the right hip (1934). In 1929 the patient had swallowed a straightened-out hairpin which two laparotomies had been unsuccessful in removing. In 1931 a roentgenogram showed that the pin had perforated through the lower duodenum and was probably lying in the retroperitoneal space on the psoas muscle. A roentgenogram at the time of the symptoms of hip disease showed that the tip of the pin had eroded and perforated the acetabulum and was partially in the joint space, which was narrowed and irregular. The pin must have wandered down for this considerable distance during three years. It was removed surgically.

HANS W. HEFKE, M D

Wandering (?) of a Bullet Case Report Ulrich *Röntgenpraxis*, June, 1935 7, 384-386

It seems to be the consensus of opinion that bullets do not wander without being carried along by a purulent abscess. A case is reported in which a bullet in the upper half of the leg travelled down to the insertion of the Achilles tendon (in more than twelve years) but was enclosed in a foreign body abscess. In another patient a bullet was demonstrated roentgenologically (1930) in the mid portion of the sternum. In 1935 it was shown at the lower tip and a 17-cm. canal could be seen in the sternum. In this case, the author believes the bullet has wandered by being pushed downward by a sterile abscess.

HANS W. HEFKE, M D

FRACTURES

Treatment of Fractures of the Carpal Scaphoid R. Soto-Hall and K. O. Haldeman *Jour Bone and Joint Surg.*, October, 1934, 16, 822-828 (Reprinted by permission from *British Med Jour.*, March 2, 1935 p. 35 of *Epitome of Current Medical Literature*.)

The authors point out the necessity of differentiating between the clinical varieties of isolated scaphoid fractures, as both treatment and prognosis vary with each type. The most common fracture is an intra-articular injury, and occurs through the body or neck. Next in frequency is an avulsion fracture of the tuberosity which is extra-articular and heals with good bony union in five or six weeks. The third and more uncommon type presents a severely comminuted fracture with considerable deformity. In the case of intra-articular fractures early diagnosis and treatment are imperative. As 60 per cent of cases are diagnosed as a sprained wrist the favorable opportunity for early immobilization has usually passed, as pseudarthrosis

increases rapidly after two weeks without proper treatment. In cases in which a fracture of the wrist is suspected, an x-ray should be taken with the hand in complete ulnar flexion. In cases of recent fracture it has been found that the best results are obtained by fixation in plaster with the wrist in 30 to 40 degrees of extension, with complete radial flexion of the wrist, the thumb being included in the position of extension and abduction. Immobilization should be continued for at least seven weeks, depending on progress and the age of the patient. In some cases immobilization may be necessary for three months. The thumb should be liberated at the end of five weeks, and in retarded cases the cast may be bivalved after eight weeks in order to begin baking and massage. In late cases and those with pseudarthrosis a bone-drilling operation is carried out, which should heal the simple scaphoid pseudarthrosis and allow proper reduction. In cases which show marked comminution and deformity, or in which lytic changes are evident, complete excision of both fragments of the scaphoid is recommended with immobilization for at least five weeks in complete ulnar flexion of the wrist.

The Calcium Stream as Concerned with the Healing of Fractures John J. Moore and Alfred A. de Lorimier *Am Jour Roentgenol and Rad Ther.*, October, 1934, 32, 457-463

Experimenting with healing of fractures in rabbits, it was noted that under ample calcium, phosphorus, and vitamin supply when the generalized tissue balance was shifted to the acid side, there was a delay in the ossification of the callus and a generalized deossification of the skeleton. When the tissue balance was shifted to alkaline the ossification of callus was furthered. This latter is best in the presence of an acid medium in the intestine as produced by lactose fermentation.

S. M. ATKINS, M D

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Retroposition of the Transverse Colon Report of Two Cases P. E. Truesdale *Jour Am Med Assn.*, May 11, 1935, 104, 1697-1700

Abnormal position of the intestinal tract is the result of some disturbance of migration, rotation, descent or fixation during embryonic life. Relatively slight variations in the different stages of development of the intestine result in such developmental anomalies as migratory colon, excessive mobility of the colon, dolichocolon, torsion of the colon or its mesentery or both common mesentery, and congenital fissure of the mesentery. In most of these cases the transverse colon is in normal position but has some defect or torsion of the mesentery. It may be very short or have exaggerated sinuosity. Lack of fixation of the mesentery and torsion from bands or adhesions may result in abnormal positions of the cecum or of the ascending transverse or descending colon, or may cause volvulus of a segment of the small or large intestine or both. Perhaps the rarest of all developmental anomalies of the colon is retroposition of the

transverse colon due to inverted rotation of the midgut during the tenth week of embryonic life. In the few cases assembled from the literature the transverse colon dips back into a tunnel behind the duodenum and superior mesenteric artery. Some constriction through torsion of the mesentery or pressure on the transverse colon then causes intestinal obstruction.

Two of the author's own cases and six others from the literature are reviewed, with illustrations to demonstrate the appearance of the viscera and the factors producing obstruction.

CHARLES G. SUTHERLAND, M.D.

Anomalies of Intestinal Rotation as a Cause of Intestinal Obstruction. Clarence E. Gardner, Jr., and Deryl Hart. *Arch Surg*, December, 1934, 29, 942-981.

This article deals with the various degrees and types of abnormalities of intestinal rotation. An excellent description of embryologic development and the mechanism of intestinal rotation accompanied by instructive diagrams is presented. The authors present two of their own cases and review 103 reported cases from the literature.

In non rotation of the midgut loop, the intestinal tract occupies the position in the abdomen fundamentally the same as in the embryo at the eighth week. The entire small bowel lies to the right of the mid line and the colon to the left. There is no secondary fixation of the mesentery, the entire midgut loop hanging free from the narrow duodeno-colic isthmus. Such an anomaly predisposes to the development of volvulus of the entire midgut loop. The term "malrotation" designates the irregular defects of rotation and fixation. In one type the prearterial segment is reduced in front of the superior mesenteric artery, while the rotation of the postarterial segment is arrested. In another type the prearterial segment remains entirely on the right side, as in non-rotation, while the postarterial segment has rotated normally but has been prevented from becoming fixed to the posterior abdominal wall by the presence of the non rotated small bowel. In both of these conditions the cecum and ascending colon retain their primitive mesentery in common with that of the small intestine. Volvulus of the common mesentery may be produced. A large intra-abdominal hernia may be simulated by the rotation of the prearterial loop into the mesentery of the postarterial segment between the superior mesenteric artery and the colon. Practically the entire small bowel may be contained in the peritoneal envelope thus formed. In reverse rotation, there is a 90-degree clockwise rotation instead of the normal 270-degree counterclockwise rotation. In this condition the transverse colon passes dorsally to the duodenum and the superior mesenteric artery. If the normal fixation of the root of the mesentery toward the right iliac fossa takes place in this position the transverse colon becomes trapped in a tunnel beneath this acquired attachment.

Volvulus with symptoms of duodenal occlusion is the more common condition which follows volvulus of the entire intestinal tract. There may be symptoms

of acute or chronic intestinal obstruction. Obstruction may be complete, partial or intermittent. In the chronic type the diagnosis should be made clinically and has been reported in 32 new born infants. It must be differentiated from pyloric stenosis and atresia of the distal portion of the duodenum. In the chronic type the feedings are taken normally for several days. Meconium and in some cases normal stools are passed. Vomiting, constipation and abdominal pain usually occur around the third or fourth day. The vomiting is persistent and projectile, occurring some twenty to thirty minutes after feeding. The vomitus contains bile. There is distention of the upper abdomen with the lower abdomen being flat or scaphoid. If vascular obstruction accompanies the volvulus, blood stained fluid may pass from the rectum. Marked degrees of acidosis and dehydration may follow. X-ray examination will reveal a markedly dilated stomach and duodenum, with the entire duodenum to the right of the vertebral column. This latter finding is of great diagnostic value from the roentgenologic standpoint. The cases of volvulus with acute symptoms are very difficult to diagnose clinically from acute intestinal obstruction from other causes unless previous radiologic studies have been carried out and the patient is known to have some type of abnormal intestinal rotation or fixation.

This article should be of equal value to the clinician, surgeon, pediatrician and roentgenologist.

ANDREW H. DOWDY, M.D.

Malignant Lymphoma of the Gastrointestinal Tract. A. C. Pattison. *Arch Surg*, December, 1934, 29, 907-922.

Malignant lymphoma is considered to be a neoplasm which arises from the lymphatic tissue and is due to proliferation of atypical cells in the lymphatic series. The condition may be localized or generalized. The group reported by the author is localized to the gastrointestinal tract and is placed in the lymphosarcoma group.

The author reports six cases. The symptomatology was not characteristic in any one case. In not a single case in this series was the pre-operative diagnosis of malignant lymphoma made. Generally speaking the average age of the patients with malignant lymphoma falls somewhat below the cancer age, and while they may vary from three and one half years to 85 years, the average age of incidence generally falls from fifteen to twenty years below that of carcinoma in the gastrointestinal tract.

The lymphomas arise in the submucosa and infiltrate the submucosa and the muscularis. Ulceration of the mucosa is not always present, but is not infrequent and when present is usually due to necrosis from pressure and loss of blood supply rather than to neoplastic invasion. Regional lymph glands are usually involved. Extension to the liver is unusual. In the stomach the lesions vary from very small localized nodules to a diffuse infiltration of practically the entire wall of the stomach. The condition may be mistaken for polyposis of the stomach or for carcinoma of the stomach. In

the small intestine, the lower part of the ileum is most commonly involved. The lesion may be diffuse, nodular, sessile, or polypoid. Aneurysmal dilatation of the intestine at the site of the neoplastic invasion is frequent, due to the destruction of the muscle fibers or to involvement of the submucosa with subsequent effect on its plexus of nerves. Obstruction is not frequent when it occurs, it is usually late in the disease and due to pressure from the enlarged mesenteric glands or as a result of fibrosis which may occur late in the disease. Intussusception is fairly frequent, the tumor occupying the apex of the invaginated loop. In the large intestines the lesions are similar to those in the small bowel, though the lumen is not often encroached upon. One of the author's cases clinically resembled carcinoma of the rectum.

Laboratory data are in no way distinctive. The roentgen ray diagnosis is usually carcinoma, though a diagnosis of gastric ulcer is sometimes made, or even of polyposis. In a fair number of cases the examination revealed no abnormalities. Changes in the blood picture are absent or of no differential value, with the exception of terminal leukemia, which is seen in some cases. In the six cases presented by the author, the clinical history, along with the roentgen ray observation and microscopic sections, is given in detail.

ANDREW H. DOWDY, M D

GENITO-URINARY TRACT (DIAGNOSIS)

Roentgenograms of a Paraneuritic Abscess. O. Spitzenberger. *Röntgenpraxis*, June, 1935, 7, 391-396.

Paraneuritic abscesses have not, heretofore, been shown directly by means of pyelography. Necessary for their direct demonstration is a communication between them and the kidney pelvis. In the case reported a flat film showed a marked unilateral haziness of the psoas shadow and absence of the kidney shadow. Catheterization of the ureter led to perforation of the kidney pelvis, which was not immediately recognized. A retrograde pyelogram showed the contrast material in the kidney and around the kidney and upper ureter. The condition of the patient became worse and the infection seemed to have been spread by introduction of the thorotrast. It seems advisable to use great caution when doing a retrograde pyelogram in cases of paraneuritic abscess.

HANS W. HEFLE, M D

GOITER

A Roentgen Study of the Chest in 200 Patients with Goiter. S. J. Hawley. *Am Jour Roentgenol and Rad Ther*, September, 1934, 32, 326-329.

In this study, the basal metabolic rate in 35 per cent was normal or lower, and in 65 per cent elevated. Of the group studied, 18 per cent had enlarged heart shadows, 89 per cent of the enlarged hearts had elevated basal metabolic rates. Of the patients who succumbed 80 per cent had enlarged hearts and showed organic heart disease at postmortem. Patients with toxic

adenoma showed a much greater tendency toward cardiac hypertrophy than those with hyperplastic thyroids. There is no characteristic heart shape in thyroid disease.

S. M. ATKINS, M D

GRENZ RAYS

Quality Determinations of Inhomogeneous Grenz Rays. H. Steps. *Strahlentherapie*, 1935, 52, 686-691.

For the definition of the quality of inhomogeneous radiation it is necessary to give, in addition to the half value layer, data regarding the degree of homogeneity. This is possible by determining the quotient of the second HVL over the first HVL (Christen and Holthusen). The author measured the first HVL and the degree of homogeneity of Grenz rays emitted from two different tubes. There was very little difference between the two radiations.

ERNST A. POHLE, M D, Ph D

GYNECOLOGY AND OBSTETRICS

Further Experience with the Protracted Fractional Dose Method in the Treatment of Carcinoma of the Female Genital Organs. Heinz Kirchhoff. *Strahlentherapie*, 1935, 53, 193-201.

At the Women's Clinic, University of Kiel, the protracted fractional dose method has been used for five years. The author gives a brief résumé of the results obtained up to now. Technique: 50-70 cm F.S.D., 1.5-2.3 mm Cu, 2.3 or 5 r per minute, 200 r (in air) per sitting and per field. From June, 1930, to October, 1932, 168 carcinomas of the cervix and ovary were treated. The dose effective in the diseased tissue varied from 800 to 4,000 r. Twenty four grew worse under treatment, 80 did not respond, 19 were temporarily improved, and one was still well in April, 1935. The remaining 44 cases (32 after operation and 12 after radium) were treated prophylactically. They were all free from recurrence in April, 1935. During the last two years the technique has been changed. The single dose is approximately 400 r on the skin and two fields are given per day in such a manner that the same field is exposed on alternating days. Two fields are given over the anterior and posterior pelvis, using a 10 X 15 cm opening. Sometimes lateral and vulvar fields are added. It is possible in this manner to apply from 4,000 to 5,000 r to the tumor during a period of from three to four weeks. During the period from November, 1932 to December, 1934, 70 cases were treated with the new technique: two grew worse during treatment, 20 did not respond, 14 were temporarily improved, and 20 were free from recurrence in April, 1935. The remaining eight cases received prophylactic x-ray therapy after operation (6) or after radium application (2). They were all free from recurrence in April, 1935. A few illustrative case histories are appended. The author feels that considerable progress has been made with the introduction of this new method.

ERNST A. POHLE, M D, Ph D

The Therapeutic Importance of Hysterosalpingography in Sterility of Women J Grünthal and R Kleitsman *Röntgenpraxis*, May, 1935, 7, 321-325

It is known that the injection of lipiodol into the uterus and tubes is not only important from a diagnostic standpoint, but also has great therapeutic value. There are many cases in the literature in which a salpingography cured sterility.

The authors' cases are of especial interest because they concern, mostly, patients in whom air perturbation had not been successful. It is understood that patients with acute or subacute adnexitis must not be examined in this way. For introduction of contrast material into the uterus, the authors are using an apparatus which allows the operator to watch the intra-uterine pressure, which should not exceed 250 millimeters of mercury. The injection is done under the fluoroscope. A film is taken immediately afterward and another 24 hours after. In some cases, intra uterine pressure of 220 millimeters dropped suddenly to 100 millimeters and a roentgenogram made after that time showed that the tube, which had been occluded up to this time was patent. The authors give morphin scopolamin before the examination. In order to make occluded tubes patent, it is necessary to maintain a uniform high pressure in the uterus for an average of two hours. An hysterosalpingography done for from three to five minutes is of diagnostic value only and not of therapeutic. This method of slow dilatation of tubes is called salpingeuryis. A few cases are reported. In most of them the tubes remained occluded for the first hour and only after an hour and a half was there contrast material seen in one or both tubes. The patient must remain in bed for twenty-four hours after this ordeal. The best time for salpingeuryis is between the fourth and the seventh post-menstrual day. Complications have not been observed by the authors. In 24 cases with negative perturbation (air method), one or both tubes could be made patent in 13 (about 54 per cent).

HANS W HEFKE, M D

Radiation Therapy with Short F S D in Gynecology Walter Schaefer *Strahlentherapie* 1935, 53, 210-216

The construction of an x-ray tube permitting the irradiation of body cavities is an effort to replace to some extent the much more expensive radium. The tube described by the author can be inserted into the vagina and by means of special attachments adequate filter, and proper aiming of the x ray beam. High doses of roentgen rays can be delivered to the cervix. Isodose charts for operation at 90 K V 4 ma are shown in the article. So far, a total of 120 cases have been treated by this new method. 35 of these represent recurrences following previous irradiation. Ten cases of carcinoma of the cervix belonged to Group IV and 70 patients to Group III. Of 16 cases with carcinoma of the cervix observed over a period of from two to three years, 10 remained well. In Group IV no cures could be obtained. Of nine patients who had developed a recurrence following previous irradiation, five survived a one- to three-year observation period. The author feels

that the preliminary results are encouraging, particularly in Group III.

ERNST A POHLE M D Ph D

Indications for Roentgen Therapy in the Monosymptomatic Metrorrhagia in the Clumacterium M C. Béclère *Strahlentherapie*, 1935, 53, 62-72

The author analyzes a series of 100 cases of women between 40 and 53 years of age who came to the clinic with the symptom of uterine bleeding. Of the group, 70 per cent proved to be amenable to roentgen therapy and the rest had to go to surgery. Fifty six were personal patients and 44 observed by the chief of the clinic. The majority of patients were subjected to hysterosalpingography, and those with abnormal findings had a curettage. The cause of the bleeding was found to be as follows: intra uterine carcinoma in 8 per cent, submucous fibroid in 10 per cent, polyp in 4 per cent, residual placenta in 3 per cent, cystic salpingitis in 4 per cent, cystic ovaries in 1 per cent, functional metrorrhagia in 51 per cent, functional infectious metrorrhagia in 10 per cent, and metrorrhagia of unknown origin in 9 per cent. A fractional treatment technique is recommended. The dose used for sterilization is usually distributed over a period of eight weeks, and one sitting per week is given.

ERNST A POHLE, M D, Ph D

Effect of Roentgen Therapy of the Medulla Oblongata on Uterine Bleeding A Kukowka. *Röntgenpraxis*, June, 1935, 7, 396-398

The center for the vasomotor nerves is supposed to be situated in the medulla oblongata. The author undertook to irradiate this region with roentgen rays (180 K V, 3 ma, 0.5 mm Cu, 150 r). All patients had excessive menses and had been treated unsuccessfully by gynecologists. In most of the 23 cases there seemed to be definite improvement. The menstruation cycle is not changed. The therapeutic effect is not permanent and dysmenorrhea, menorrhagia, etc., therefore are not benefited for any length of time. The blood pressure was not changed. The effect of irradiation is apparently due to stimulation of the vagus or sympathetic nerves or vasomotor system.

HANS W HEFKE M D

Some Reasons for Not Introducing Placentography into Practical Radiologic Obstetrics A Tommaselli *Archivio di Radiologia*, 1934, 10, 763-789

The author's experiments contra indicate placentography in obstetrics as the effects of thorium salts used in the technic are deleterious to both mother and fetus.

E T LEDDY M D

HEART AND VASCULAR SYSTEM

The Roentgenkymograph as a New Aid in the Diagnosis of Adhesive Pericarditis Sydney E Johnson *Surg., Gynec. and Obst.* August 1935 61, 169-175

The author studied the roentgenkymogram of a case of adhesive pericarditis and found the results of diagnostic value. The roentgenkymograph employed was constructed (at no great expense) by the author, since this instrument is not at present available on the market. The author credits Dr. I. Seth Hirsch with bringing this method of roentgen examination to the attention of American roentgenologists and for pioneer work in its further development.

The roentgenkymograph records on an x-ray film the amplitude of excursion of the heart borders during one or more cardiac cycles. The x-ray beam passes first through the patient and then through narrow horizontal slits in a stationary lead grid. The film is kept in motion at a uniform rate of speed and in a direction perpendicular to the slits throughout the exposure. The amplitude of pulsation of each portion of the aortic and cardiac shadow is shown in the curves which represent that portion of the cardiac silhouette.

The roentgenkymogram shows the chest shadow divided into transverse bands; the width of the bands representing the distance the film has moved downward during the exposure. Since the movement of the film is downward, the recording of the curves of the excursions of the heart borders begins at the lower margins of the bands. Each individual curve represents the outward and inward movement of the portion of the cardiac border which lies in the line of the particular slit in the grid. Therefore, the curve represents the movement of a portion of the heart border which has the same length as the width of the slit and not the length of the distance travelled by the film.

The case of adhesive pericarditis presented by the author showed no evidence of excursion of the left ventricle on the roentgenkymogram. The aorta showed only a slight ripple and the right border showed no movement. With the exclusion of other conditions which might produce a stationary left ventricular border, the diagnosis of adhesive pericarditis was made. This conclusion was confirmed at operation.

The author describes his roentgenkymograph, which consists essentially of the following: (1) a framework, (2) a movable cassette carriage, (3) a timing device, (4) the lead grid, (5) an electric contact switch, and (6) a vertical support. He employs a No. 2 oil-cylinder door closer as the timing device. The lead grid consists of lead bands 12 mm. wide, separated by strips of paper 0.4 mm. thick.

J. N. ANÉ, M.D.

The Diagnosis of Aneurysms of the Abdominal Aorta
Albrecht Hartung. *Röntgenpraxis*, May, 1935, 7, 308-310.

The roentgenologic diagnosis of aneurysms of the abdominal aorta may be made directly or indirectly. The indirect signs are erosion of bodies of the vertebrae, occasionally erosion of ribs or transverse processes of the lumbar vertebrae. The direct signs are displacement of the stomach and colon by the aneurysms, or a pneumoperitoneum. In some cases calcification may be seen in the wall of the aneurysm—such a case is de-

scribed in detail. The large pulsating tumor did not cause any symptoms.

HANS W. HEFKE, M.D.

HODGKIN'S DISEASE (DIAGNOSIS)

Changes in the Bone in Hodgkin's Granuloma. Lloyd F. Craver and Murray M. Copeland. *Arch. Surg.*, June, 1934, 28, 1062-1086.

One hundred and seventy-two cases of Hodgkin's granuloma proved histologically, are studied. Twenty-seven patients, or 15.7 per cent, were found to have involvement of the bones. The age incidence was very similar to that of the general group with Hodgkin's granuloma. The greatest age incidence was found between 17 and 40 years, the age extremes were 17 and 57 years. The ratio of males to females was about equal. Pain preceded demonstrable invasion of the bone in 17 cases. It was described as a dull aching or severe and lancinating type, most frequently referred from the lumbar region to the lower extremities and was accentuated by change in posture. Girdle changes were experienced with vertebral changes. The bones most frequently involved were found to be those of the spine and pelvis. Pathologic fractures were found to be rare, but collapse of the vertebrae was frequent. The intervertebral discs were rarely involved. The osteoplastic and osteolytic types of osseous changes were noted. A combination of both was seen in many cases. Two routes of osseous involvement were assumed: (1) from the marrow foci of Hodgkin's granuloma, (2) from the contiguous diseased lymph nodes from which direct infiltration into bone occurred.

Hodgkin's granuloma affecting bone may be confused with metastatic deposits in the bone from carcinoma, neoplastic processes such as lymphosarcoma and the leukemias. Ewing's tumor may be simulated during certain phases of the osseous invasion. Less frequently the condition has been confused with various forms of osteomyelitis, including Garré's osteomyelitis. In one case a lesion of the rib had many of the characteristics of a cyst of the bone. A careful physical examination and a history, with biopsy, usually suffice to differentiate the condition.

Irradiation therapy remains the treatment of choice, the preference being given to roentgen rays in most cases. In recent years the treatment has consisted of high voltage roentgen ray either in suberythema or fractional doses depending upon the local and general condition of the patient. More attention than formerly has been paid to the treatment of the mediastinum and retroperitoneal regions when there was demonstrable or presumable involvement of these areas. No routine dosage is applied. Each case is individualized. The treatment regarded as best is that which will secure the best palliation for the longest time. The treatment should never be so severe as to make it seem harder to bear than the disease. The skin should be spared severe reaction. In the last two years Heublen's method of prolonged, continuous, low intensity irradiation of the entire body has been employed. It has been found to

be a valuable part of the treatment in a number of the cases

ANDREW H. DOWDY, M D

THE KNEE JOINT

Our Experience with Tuberculosis of the Knee Joint
V Schiller and W Altschul *Röntgenpraxis*, May, 1935, 7, 294-302

In the experience of the authors tuberculosis of the spine is found most frequently, considering all cases of tuberculosis of the skeleton (675 cases). Tuberculosis of the knee joint has the second place (11 per cent of all cases). Of the entire group, 68 per cent were men, 32 per cent were women, and about one half of the cases were persons between 21 and 30 years of age.

A study of the patients with tuberculosis of the knee shows that there is no uniform characteristic type but many different types. The early stages, which usually involve only the capsule, may show no bony lesion, the joint-space might be widened by an exudate. The bone atrophy which is typical in many other joints may not be present at all. When the process invades the bone, there are, first, small erosions on the edges of the joint surfaces. The spine of the tibia may be invaded without other changes. In the dissecting type of tuberculosis areas of bone destruction and separate bone sequestra may be seen. The largest percentage of cases shows a destruction of the joint surfaces with early ankylosis and atrophy.

The treatment is general (medication, diet, rest, sunlight) and local (roentgen rays). Two fields are used (lateral and medial), 150 to 200 r being given to each field and repeated in about four weeks. Orthopedic measures are, of course, used to insure rest of the joint. About three fourths of the cases could be dismissed symptom-free and able to work.

HANS W HEFKE, M D

THE LIVER

Rare Roentgenologic Findings of Calcium Deposits in the Liver and its Surroundings
Kurt Freese. *Röntgenpraxis*, June, 1935, 7, 368-373

In one patient the liver was seen to contain multiple disseminated, calcified areas up to the size of a marble. Echinococcus, calcified hemangioma, calcified abscesses, calcified tuberculosis, syphilitic or calcified metastases were thought of. The history, the finding of other calcified glands and the shape of the calcified nodules make the author believe that this unusual appearance is due to old healed tuberculosis.

The second case showed large irregular areas of calcification in the liver region. A lateral film showed that they were arranged more or less in one plane and were situated just below the diaphragm. The diagnosis was old, calcified subphrenic abscess.

A third case showed the necessity of fluoroscopic and lateral examinations by which a large calcified area in the region of the liver was definitely localized in the diaphragmatic pleura.

HANS W HEFKE, M D

THE LUNGS

The Radiomorphologic Appearance of Hydatid Disease of the Lung
Romano Vercesi. *Arch di Radiol*, 1935, 11, 36-47

Vercesi shows by means of 28 reproductions of roentgenograms how the "typical" picture of hydatid disease in the lung may vary with the stage of the lesion. For the examination of the chest the author prefers the roentgenogram to the roentgenoscope. The size of the lesion is not as important as its density in determining its age. In the early stages there may be only slight reactive pneumonitis but in the later ones marked pulmonary changes may be demonstrated.

E T LEDDY, M D

Physical Remarks Concerning the Etiology of the St. Joachimsthal Carcinoma of the Lung
H Tschelmitz. *Strahlentherapie*, 1935, 53, 269-275

The well known cases of carcinoma of the lung which have been observed for many years in St. Joachimsthal were supposed to be due to the inhalation of radium emanation. The author undertook a very detailed study of the etiology of the disease, and comes to the conclusion that while the inhalation of the radium emanation may be one factor, silicic acid and its salts are the principal cause.

ERNST A. POHLE, M D, Ph D

LYMPHOSARCOMA

Lymphosarcoma. A Clinical Pathologic and Radiotherapeutic Study with a Report of 30 Cases
Max Cutler. *Arch Surg*, March 1935, 30, 405-441

The material consists of an analysis based on 30 cases of microscopically proved lymphosarcoma. The patients were selected from the Veterans' Administration Facility and do not represent a random sampling of the population but constitute a rather selected group discharged from military service being the primary criterion for admission. The minimum age at the onset of symptoms was thirty years and four months, the maximum age sixty-one years and three months, the mean age 43.2 years. The end results in every case were known and autopsy was obtained on 13 of the patients who expired in the hospital. The clinical, roentgenologic and pathologic observations are correlated. Lymphosarcoma is divided into two major clinical groups: (1) a generalized form with widespread involvement of the lymph nodes and (2) a localized form with a single group of lymph nodes involvement. The localized group is comparatively rare. In the author's series there were 25 of the generalized type and five of the localized type. Histologically the condition is generally divided into two groups: (1) reticulum-cell sarcoma or large round cell lymphosarcoma arising from the reticulum and (2) malignant lymphocytoma arising from the lymphocytes. The generalized form is notorious for its recurrence following treatment.

Clinically and histologically lymphosarcoma of the tonsil and nasopharynx can be easily confused with

lympho-epithelioma and transitional-cell carcinoma All three lesions are highly and equally radiosensitive In many of the cases the similarity is so striking that a differential diagnosis is exceedingly difficult

Three cases of lymphadenoma are included in this series The differentiation of this condition from lymphosarcoma is quite difficult The distinction is based on the clinical course and the microscopic appearance of the tissues Lymph node involvement is localized The course is characteristically chronic and benign Microscopic section fails to show the criteria of malignancy

If involvement of the mediastinum is extensive, the clinical and roentgenological features simulate tumors of thymic origin The histogenesis of thymic parenchyma being undetermined, it is not feasible to classify these tumors From the therapeutic viewpoint, there are two distinct and different groups One is highly radiosensitive and the other is markedly radioresistant

In the generalized form of lymphosarcoma the radiation treatment must be applied to large areas of the body and should include all lymph node-bearing areas, although clinically they are not involved but are regarded as potentially involved The radiosensitivity of the tumor makes adequate treatment possible With a few exceptions, the author has utilized the principle of irradiating this type with daily doses for a period of four or five weeks, the general condition of the patient being kept in mind The localized forms are treated more vigorously because of the limited extent of the disease One patient with a localized mass of cervical lymph nodes and no other clinical involvement of the disease received 80 000 milligram hours of radium at a distance of 10 centimeters over a surface area 10 centimeters in diameter over a period of three weeks

The generalized form of the disease may be arrested for varying periods and may sometimes be controlled for years In the rare localized form the disease can be eradicated This result is sometimes followed by the appearance of the disease elsewhere in the body, but occasionally an apparent cure can be accomplished the patient remaining well and free of the disease for as long as ten years Fifty seven per cent of the cases are dead The minimum duration of life from the onset of symptoms to death is two months, the maximum duration, four years, the average duration sixteen months In the patients alive the minimum interval from the onset of symptoms to Feb 1 1934 was ten months maximum, six years and six months, the average, three years Including all cases the average interval from the onset of the disease to death or to Feb 1 1934 was approximately two years Four patients are alive and clinically free from the disease The interval of freedom from the disease ranges between two and six years Twenty three of the 28 patients treated by irradiation or 80 per cent, were benefited by the treatment Regression of the tumor relief from the pain, and improvement in the general condition of the patient constituted the immediate primary result following treatment

ANDREW H DOWDY M D

PELVIMETRY

The Orthodiagraphic Principle in Pelvimetry Eugen von Engelmayr *Röntgenpraxis*, May, 1935 7, 289-294

The orthodiagraphic method has been applied by the author to the measurement of the female pelvis The true transverse diameter can thus easily be determined without special positioning of the patient A film made in Albert's position is taken and the transverse diameter is determined and compared with the diameter measured by orthodiagraphy From this proportion the true measurement of the conjugata vera can be figured from the film, also the true measurements of the oblique diameters The method might be controlled by Guthmann's technic (lateral view with lead marks) The modification of the author avoids the measurement of focus film distance, height of symphysis, etc, and employs a simple mathematical proportion instead of complicated geometrical figures The method is inexpensive, simple, quick, and harmless It might be possible to use the method also for measurements of the head of the fetus

HANS W HEFKE, M D

PEPTIC ULCER

Roentgenologic Evidence of Healing of Jejunal Ulcer Jacob Buckstein *Am Jour Roentgenol and Rad Ther* October, 1934, 32, 487-492

As in peptic ulcers, retrogressive changes or total disappearance of the niche in jejunal ulcer is a reliable guide in its healing This however, must be correlated with the clinical findings, for the niche may not be seen when the ulcer pocket is closed by spasm, food, mucus, or blood Cases are presented

S M ATKINS, M D

The Radiologic Aspects of Ulcer of the Duodenal Bulb, with Special Regard to its Evolution and to the Duration of the Disease Giovanni Baldelli *Arch di Radiol*, 1935, 11, 5-28

Baldelli reports a study he made on 50 cases of duodenal ulcer, 45 of which had operative proof He discusses and illustrates the roentgenographic appearance of the duodenum in four stages of ulcer

E T LEDDY, M D

PNEUMOTHORAX

Giant Excavation and Emphysematous Bulla Mistaken for Pneumothorax A Report of Two Cases A A Karan and Webb Haymaker *Am Jour Roentgenol and Rad Ther*, September, 1934, 32, 322-325

Two cases are presented by the authors which were mistakenly diagnosed as pneumothorax In the case of giant excavation occurring in a young male, aged 19, the upper lobe and most of the lower lobe of the left lung were found at autopsy to be transformed into a single giant excavation, the cavity measuring 26 X 12 X 11 cm, and communicating with the upper main bronchus The roentgen film appearance was one of

unusual radiability of the upper three fourths of the left lung-field, with a fluid level which was mistakenly interpreted as hydropneumothorax.

In the case of large emphysematous bulla occurring in a male, aged 49, the postmortem examination revealed a giant dilated air-containing bulla originating from the upper border of the lower lobe of the right lung. The sac measured 9 cm in its vertical diameter, and its wall composed of a fibrous structure, measured 2 mm in thickness. Proximal to the pedicle of the bulla was a shallow blind ending the base of which was non emphysematous pulmonary parenchyma. It was without direct communication with the bronchial tree. Subpleural and interstitial emphysema were present throughout the two upper lobes. The roentgen film of this man revealed increased density over the right middle and lower lobes interpreted as pneumothorax with fibrotic tuberculous disease in both upper lobes.

The authors conclude with the statement that bronchoscopy with lipiodol instillation would have offered valuable diagnostic evidence in establishing the correct diagnosis in each case.

J EDWIN HABBE M D

The Superior Value of the Expiratory Roentgenogram in the Diagnosis of Incomplete Pneumothorax. Sidney Greenberg. *Am Jour Roentgenol and Rad Ther*, September, 1934, 32, 330-332.

The writer found increased diagnostic value in the expiratory roentgenogram over the routine inspiratory film in the detection of small pneumothoraces and he attributes the increased diagnostic value to the fact that the volume of the pneumothorax remains practically constant during respiration, while the surface of the pleural sac is decreased during expiration as a result of which the layer of air about the lung becomes somewhat thicker at the end of expiration, moreover there is greater contrast offered because of increased density of the lung tissue at the expiratory phase.

J EDWIN HABBE M D

A Case of Spontaneous Hemopneumothorax. Joseph L. Frey. *Jour Am Med Assn* April 20 1935, 104 1395-1399.

Hemopneumothorax is not a common condition. The majority of cases follow trauma, either in military or in civil life but the spontaneous form is distinctly rare. The author found only 13 cases recorded in the literature in the present century ten had no associated demonstrable disease or trauma and the remaining three were due to tuberculosis, one of them complicated by artificial pneumothorax. The term 'hemopneumothorax' is applied to cases of lung collapse with undoubted blood and air within the pleural cavity and not just blood stained serum (hemorrhagic effusion), such as is occasionally seen in malignant disease of the lung.

The author reviews in detail the 13 cases from the literature and reports a case with recovery in a young man. Four of the 13 cases came to necropsy three

of these showed a torn pleural adhesion and a torn or ruptured emphysematous bulla. The other one showed no definite cause for either the pneumothorax or the hemorrhage into the pleural cavity. All the cases occurred in males.

CHARLES G. SUTHERLAND, M D

PROTECTION

The Dangers of Roentgenoscopy and Methods of Protection against Them (1 General Review of the Problem) Eugene T. Leddy, Earl I. L. Cilley, and B. R. Kirklin. *Am Jour Roentgenol and Rad Ther* September, 1934, 32, 360-368.

Since 1918, lead rubber gloves and aprons as protection, have been discarded in roentgenoscopic examinations. The only precaution is celerity of examination and the use of as small a field and effective beam as necessary. None of the examiners each of whom have been thus exposed to many thousands of gastro intestinal examinations over a period of seven or eight years, have shown either local or general roentgen injuries. By both ionization and photographic measurements each has received more than the so-called tolerance dose. In spite of the apparent absence of danger from this method, nevertheless, the authors advise emphatically that roentgenologists continue to observe the recommendations of the International Safety Committee.

S. M. ATKINS M D

RADIATION EFFECTS

The Constitutional Effects of X rays as Determined by Blood Serum Tests. S. Gilbert Scott and F. Herniman Johnson. *British Jour Radiol*, June, 1935, 8, 365-372.

The authors discuss the application of lightly filtered x-rays of medium or long wave length to a large body area to produce constitutional effects as determined by the vanadic acid test of the blood serum. In the case of ultra-violet radiation the constitutional action depends upon the following: (1) chemical changes in the surface tissues, (2) effects on cutaneous nerves, (3) effects upon the blood and lymph circulating in the integument. Besides these, many more factors may be present in the consideration of the action of the x rays, for all organs and tissues in the path of the beam may be affected by the roentgen rays.

While in the past various clinical manifestations were noted following irradiation given to produce constitutional effects there was no direct proof that constitutional alteration had occurred. The vanadic acid test has supplied this proof and is now being employed in radiotherapy to show the changes in the patient's make-up as a result of treatment. The general principle on which the test is based is that ortho-vanadic acid has the property of causing a precipitate in blood serum. Within certain limits the amount of the precipitate is determined by the acidity of the vanadic solution which is added. A series of tubes numbered from left to right containing different strengths of vanadic acid is employed. Each tube is numbered on the basis of the

actual vanadic acid content. In the case of normal blood, the first definite precipitate occurs in the tube containing 27 c.c. of n/10 vanadium in 200 c.c. of precipitating reagent. It was found by Bendien who originated the test, that, in active carcinoma, a "shift to the left" occurred, with the maximum precipitate occurring in tube 25 or 24. It has also been determined that if the serum is heated to 56 degrees C a "shift to the right" takes place, and if the serum is treated with ether a "shift to the left" occurs. The tube contents are examined with an instrument known as an interferometer. The refractive index of the media is proportionate to the amount of dissolved precipitate. The interferometer reading of normal serum in tube 27 has been arbitrarily placed at 40 interferometer units. With these facts, the authors have constructed three graphs showing the untreated serum, the shift to the right after heating, and the shift to the left after treatment with ether. The three curves thus define two fields. The area on the right is colored green and that on the left, red. This arrangement makes it possible to speak of the size, shape, and relations of the green and red fields. Thus, a large red field is interpreted as indicating a pronounced toxicity factor and a small green field accompanied by a leftward shift, as indicating a low resistance. While it is not believed that the test is of any value in the diagnosis of cancer, it is thought that it is of great value in the control of x-ray treatment and in prognosis.

The three conditions studied by the authors, which give positive vanadic acid test readings, and also are influenced clinically by appropriate x-ray treatment are asthma, spondylitis adolescens, and cancer of the breast.

In the treatment of asthma by this wide-field therapy method it was noted that results were more satisfactory if the abdomen, rather than the thorax was exposed. These clinical findings were confirmed by the vanadic acid tests. This was believed due to the following factors: (1) effect on the digestion glands, indirectly affecting metabolism; (2) effect on the suprarenals; (3) effect on the solar plexus. It was further determined that the best results were obtained in the typical allergic non-bacterial type. The vanadic test here showed a very small green and a large red field. Suitable x-ray treatment resulted in a normal graph accompanied by a cessation of symptoms. Using the serum tests the authors have been able to determine which cases of asthma will be benefited by x-ray therapy.

Spondylitis adolescens results in a definite shift to the left: a small green and a large red field. X-rays of medium wave length are applied in two fields so as to include the whole of the back. The vanadic acid test is used to indicate the course of the treatments for as in the case of asthma overdosage results in a definite shift in an adverse direction. The authors believe that at least one year is necessary to effect a cure in a suitable case.

The authors believe that in carcinoma of the breast after the removal of the primary growth the problem

of preserving the patient from metastases becomes a constitutional one. The vanadic acid test of the blood serum is believed a valuable indication of the condition of the patient. The authors are of the opinion that wide field x-ray therapy of low intensity and medium voltage is an effective agent in restoring or raising the resistance of the patient. The serum tests have proven this to be true, in their investigations.

J. N. ANÉ, M.D.

Gastric Ulcers Appearing after Roentgen Exposure
Rolf B. Engelstad *Strahlentherapie* 1935, 53, 130-170

Following a brief review of the literature dealing with the effect of roentgen rays on the stomach the author describes in detail his extensive experimental studies on 79 rabbits. He exposed the thorax, including part of the stomach, and also the stomach region directly. Three rabbits served as controls. In 27 rabbits the stomach was found to be normal macroscopically as well as microscopically. In 42 animals there were degenerative changes in the mucous membrane, in 25 definite ulceration and in six scars. Eight of the ulcers had perforated. The degeneration of the mucous membrane may involve all cell elements but the principal cells seem to be most sensitive. The tolerance of the mucous membrane of the stomach for roentgen rays seems to be about the same as that of the skin or perhaps slightly lower. A slight initial reaction appears immediately after the exposure and after a latent time of about one week the principal reaction occurs. The changes disappear within three months but may last as long as five months. The appearance of the ulceration is very similar to that of peptic ulcers in the human. Technique used was as follows: 175 K.V., 4 ma., 27 cm. F.S.D., 0.5 mm. Cu. 1,700-15,000 r. An analysis of the entire material leads the author to the conclusion that the observed ulcers are not due to roentgen injury alone, but in all probability represent acute or subacute gastric ulcers which develop on the basis of the roentgen changes in the mucous membrane.

ERNST A. POHLE, M.D., Ph.D.

The Length of the Path of Alpha Rays in Living Substances
Ferd. Herčík and M. Dušek *Strahlentherapie*, 1935, 53, 178-192

The authors determined photographically the length of the path of alpha rays of RAF in living substances (plant cells), it amounted to approximately 95 μ .

ERNST A. POHLE, M.D., Ph.D.

RADIUM

Report Concerning the Effect of Radium Chloride Injections
Walter Altschul *British Jour. Radiol.* June 1935, 8, 396, 397

The author reports the results of his experiences with the injection of an aqueous solution of radium chloride furnished to him by the 'Radiumchemawerke' Koln. He claims 'excellent permanent results' with this form of therapy in the treatment of 'inflammatory processes in muscles and joints (which we include under the general term of rheumatism),

gout, arthritis deformans, and all types of neuralgia especially sciatica "

The author's technic consists in the administration of a series of six injections, which are usually given on consecutive days, or with a maximum interval of one day between two doses. One microcurie is administered in the first three injections, and two microcuries in the last three injections. The series may be repeated after about three weeks.

The author presents one case in detail but includes no statistics of cases treated by this method.

J N ANÉ M D

A Radium Dosage Calculator H S Souttar
British Jour Radiol, June 1935 8, 385-392

The author describes a radium dosage calculator which consists of a specially divided scale so constructed that for a milligram of radium placed at any point of the scale the reading at that point gives in r units the radiation at the origin of the scale. This scale is a scale of inverse squares and is based on the accepted figure of 8 r units per hour as being the radiation from a milligram of radium element, at a distance of 1 cm with a filtration of 0.5 mm of platinum. By the use of an accessory device in the form of a square, with holes drilled along one of its limbs, it is possible to calculate the radiation in a plane other than that in which the radium is distributed.

J N ANÉ M D

Experimental Contribution to the Effect of Radium Chloride Solution Walter Altschul Strahlentherapie 1935, 53, 187-192

The author studied the effect of radium chloride solution on the eye of rabbits. Doses smaller than 1 mc did not produce any changes, while injections of 1 mc and higher caused severe inflammatory changes. He concludes that therapeutic doses less than 1 mc are of little value.

ERNST A. POHLE, M D Ph D

ROENTGEN-RAY BURNS AND INJURIES

Contribution to the Problem of Roentgen Carcinoma
Roland Müller Strahlentherapie, 1935, 53, 261-268

Eight cases of roentgen carcinoma are briefly reported. Seven of these occurred in patients who had received treatment during the years 1920 and 1921 and one had the first treatments in 1919 which were continued in 1925. Six patients had been suffering from psoriasis or cervical adenitis, one had a recurrence following operation of a cancer of the breast and one had a melanosarcoma removed. Mechanical irritation apparently played an important rôle in the development of these roentgen carcinomas.

Clinically and histologically they are similar to a primary skin carcinoma. Some roentgen carcinomas respond well to radium therapy or electrocoagulation. Infiltrating tumors should be excised widely.

ERNST A. POHLE M D Ph D

ROENTGEN-RAY THERAPY

The Quality of High Voltage Radiations I W V Mayneord and J E Roberts British Jour Radiol, June, 1935, 8, 341-364

Two of the most important considerations in the employment of high voltages for therapeutic purposes are the measurements of "quantity" and "quality" of the radiations produced. Observations on the former by the authors have been published and in the present study they discuss questions relating to the composition of the beam.

The measurement and definition of the "quality" of a monochromatic beam of rays is relatively simple for it may be defined simply as the wave length of the radiation, and the measurement may be obtained by means of the standard wave length determination. However in the case of a heterogeneous beam a statement of the complete energy distribution in the spectrum is required. The method of measurement of quality by using an ionization or photographic spectrometer as its basis is considered too lengthy and complex to be normally employed in therapeutic practice. The methods most generally employed are the following: (1) the partial absorption curve of the radiation in a standard substance such as copper, (2) the effective wave length determination and (3) the measurement of "half value layer" ($h \vee l$).

The first method which is the most recent consists in finding by trial a constant high potential which produces radiation having the same absorption curve in copper as the radiations in question. The constant high potential employed is known as the "equivalent constant potential" and serves to define the quality of the radiation.

The second method, which involves the measurement of the effective wave length, has been a very popular method. The original form of this method as proposed by Duane consisted in measuring the amount of aluminum necessary to cut down the observed ionization due to the primary beam to the same fraction as a standard thickness of copper. Since the ratio of aluminum to copper depends upon the wave length, an equivalent wave length may thus be defined. As the energy distribution of radiation transmitted by the copper depends upon its thickness the resultant wave length is variable with the thickness of copper chosen as a standard. Another form of the effective wave length measurement consists in determining the percentage transmission of the radiation through a standard thickness of copper such as 0.25 or 0.5 millimeter. While this is a very convenient and simple method particularly in the region of from 150 to 200 K V the authors do not believe it is applicable over a very wide range of frequencies. Another disadvantage noted is that the relative transmission observed is a measure of the reduction in ionizing power not of the energy of the beam.

The third method consists in finding the thickness of material the so-called half value layer ($h \vee l$) which reduces the dosage rate of a given beam to one half of

its initial value For very long waves, celluloid or aluminum is used and for normal therapeutic voltages copper is employed While lead has been suggested for 'superhard' rays, the authors are of the opinion that tin is the most suitable material For accurate work $h \nu$ should be expressed in gm/cm In the opinion of the authors, the $h \nu$ method is, at the present time, the method of "quality" determination least open to criticism

It has been shown by spectra of high voltage radiations through lead, tin, and copper that tin is superior as a filter The authors conducted many ionization experiments which also demonstrated this fact This is further shown in the actual therapy conditions at the Cancer Hospital where, at 350 K V, about 60 per cent more radiation of the same quality was obtained by substituting 1.68 mm Sn for 3.8 mm Cu It should be remembered that at high voltages it is never necessary to increase the thickness of copper backing to the tin beyond 0.5 mm Cu, however thick the tin itself may be

J N ANÉ, M D

THE SKIN

Contribution to the Sensitivity of Human Skin to Light H Danneel *Strahlentherapie*, 1935, 53, 171-177

The author studied the influence of red rays on the degree of erythema in the human skin produced by ultra-violet rays Experiments on 80 normal adults showed that there is a slight influence on the ultra-violet light erythema if the skin is heated up to the point of a burn Slight reddening of the skin due to the application of hot air did not increase the erythema following ultra violet radiation

ERNST A POHLE, M D, Ph D

THE SPINE

Observations on Spondylolisthesis and the Slipping of Vertebrae Ernst Friedl *Röntgenpraxis*, June 1935, 7, 374-379

Spondylolisthesis of the fifth lumbar on the first sacral vertebra is not an unusual disease The true type shows a split in the arch Pseudo-spondylolisthesis shows a normal arch, but slipping of the vertebrae (Jungmanns) Lateral displacement of vertebrae in cases of marked scoliosis has been known for a long time

In a true spondylolisthesis (usually the fifth less often the fourth lumbar vertebra and rarely other vertebrae) the arch is split bilaterally If the fifth intervertebral disc degenerates, the normal fixation between the fifth lumbar vertebra and the first sacral segment becomes loose and the entire spine slips gradually forward on the inclined plane of the first sacral vertebra Usually the anterior displacement is one-third or one-half of the width of the vertebra Occasionally there may be a complete anterior dislocation Arthritic processes follow

That the defect in the arch is not essential to spondylolisthesis is shown in cases in which the arch is intact (pseudo-spondylolisthesis) In these cases degeneration

of the intervertebral disc is the essential etiological factor (as also in the true type) Any type of spondylolisthesis must be considered as a roentgenologic symptom of degeneration of the intervertebral disc, sometimes in connection with calcification of the disc, hypertrophic spurs deformity of the disc and Schmorl's bodies The bilateral split in the arch is probably a congenital anomaly A fracture is very improbable

Posterior spondylolisthesis has been reported, but mostly in the upper lumbar spine

True spondylolisthesis is not traumatic The author's opinion (and his chief's, Prof Schunz) is that a single trauma is not the cause of the three types of spondylolisthesis

HANS W HEFKE, M D

Spondylitis Deformans of Cervical Spine as Cause of So-called Brachial Neuralgia and Other Neuralgiform Pains Question of Therapy A Rydén *Nord med Tidskr*, Dec 1, 1934, 8, 1636-1638 (Reprinted by permission from *British Med Jour*, March 30, 1935, p 52 of *Epitome of Current Medical Literature*)

The author draws attention to the frequency with which the lowest cervical vertebrae are involved in spondylitis deformans The nervous manifestations are much more prominent than the structural changes in the bones themselves, and the latter are liable to be overlooked unless special attention is drawn to them The nervous manifestations consist often, but not always, of pain radiating to one arm, up one side of the neck or to the axillary region, and sometimes there may also be paresthesia and weakness of the arm Atrophy is, however, rare The x-rays have shown that spondylitis deformans of the cervical region is so common in old age as to be almost normal at that period, and it has been suggested that the pain and other nervous manifestations already referred to are incidental concomitants of, not sequels to, the spondylitis Among the many reasons the author gives for not accepting this view is the observation that the nervous manifestations diminish or disappear when the cervical region is immobilized by plaster-of-Paris or a celluloid splint Since 1928 he has applied this treatment to some 30 cases at the Orthopedic Hospital of Lund, Sweden, and the results have been so encouraging that he regards this treatment as the most satisfactory means of relieving the pain and discomfort of this disease One of his patients who has worn a celluloid neck splint for years has found that after wearing it for a week or two he can dispense with it for the same length of time, and he resorts to it again only when the pain recurs

Clinical Importance of Intervertebral Discs with Special Reference to Nuclear Prolapses G B Bush *Bristol Med-Chir Jour*, 1934, 51, 173-182 (Reprinted by permission from *British Med Jour* Jan 26 1935 p 15 of *Epitome of Current Medical Literature.*)

The author draws attention to the importance of the intervertebral discs in the structure and function of the

spine, with special reference to a condition found mainly in young adults, which is characterized by a mild degree of kyphosis together with a varying amount of pain in the back. It is considered that by early recognition of certain changes which take place in the structure of the spine deformity and chronic pain can be prevented. Radiography in these cases may show irregular contours of the upper and lower margins of the vertebral bodies, generally in the lower dorsal region, several vertebrae being affected. These irregular contours are due primarily to changes in the intervertebral discs. The function of these discs is to give flexibility to the spine as a whole and to act as a series of shock absorbers. The cartilage end-plate is a vital part of the normal disc, and when injury to this takes place the result may be serious as regards the whole spine. Severe trauma may rupture the plate, together with the vertebral body, or destructive disease starting in the bone may lead to partial or complete dissolution of the cartilage plate. In certain cases the injury to the end plates is due to injurious influences of wear and tear working on cartilages which are in some way inferior in their resistive power. This inferiority may be due to osteoporosis of the vertebral spongiosa during growth from lack of calcium, or to slight hemorrhages which may start the formation of a minute fissure in the region of the bearing surface of the end plate. The weight of the body causes pressure, with subsequent prolapse of the nucleus through the fissure and the formation of a zone of sclerosis round the nucleus. Five cases are reported in which injury to the intervertebral disc had caused symptoms of pain and spinal weakness. Two cases were treated by rest, massage, and exercises with good results, but in the remaining three cases calcification in the nucleus or scoliosis had taken place, and the condition was too advanced for successful treatment.

The Roentgenographic Appearance of Fracture of the Transverse Process of the Lumbar Vertebrae Luigi Ferretti Arch di Radiol, 1935, 11, 48-59

Ferretti discusses the roentgenologic findings in five cases of fracture of a lumbar transverse process and points out the important differential points in regard to this lesion and the pitfalls in its diagnosis.

E T LEDDY, M D

THE STOMACH

An Acquired Diverticulum on the Anterior Wall of the Stomach R Kaiser Röntgenpraxis, May 1935, 7, 327-329

Most of the diverticula of the stomach are congenital and found in the cardiac end. The case reported showed a diverticulum about the size of a walnut in the anterior wall of the stomach and fixed to the abdominal wall. In the author's opinion this diverticulum was due to an operation done eighteen years before for an epigastric hernia. It could be shown only on lateral examination and was entirely obscured on the antero-posterior view.

H W HEFKE M D

SYMPATHETIC NERVOUS SYSTEM

Roentgen Therapy of the Sympathetic. Carlo Guarini Archivio di Radiologia, 1934, 10, 649-762

In this extensive paper (97 pages of text and 15 pages of bibliography) Guarini reviews the present status of irradiating the sympathetic nervous system as an indirect method of treating various benign and malignant affections and shows that this extensive field in radiotherapy has at present hardly been entered.

E T LEDDY, M D

THE THORAX

A Case of Peculiar Round Shadows in a Thoracic Roentgenogram Hellmut Bauer Röntgenpraxis May 1935, 7, 313-316

On a chest roentgenogram of a 16 year-old patient there was a marked kyphoscoliosis. Two large, bilateral round, well-circumscribed and dense shadows were noticed in the hilar regions. The appearance led to the tentative diagnosis of calcified mediastinal tumors or cysts or echinococci. By means of lateral roentgenograms these peculiar shadows were shown to be calcified paravertebral tuberculous abscesses.

HANS W HEFKE M D

THE THYMUS

Does the Thymus Influence the Number of Granulocytes? Stevo Radojevic and Arpad Hahn Strahlen therapie, 1935, 53, 90-101

It is known that in patients with hyperplasia of the thymus the number of lymphocytes in the blood is increased. The authors advance, therefore, the hypothesis that the thymus may have a controlling influence on the granulocytes. They support their contentions by two clinical observations in a case of malignant thymoma and one of mediastinal lymphosarcoma. The blood record of these patients showed a steady drop in the granulocytes until their death from the disease.

ERNST A. POHLE M D, Ph D

THE THYROID

Malignant Diseases of the Thyroid Gland U V Portmann Am Jour Roentgenol and Rad Ther, October, 1934, 32, 508-515

In malignant tumors of the thyroid the failure of the histologic morphology as a criterion in their classification and clinical course is even greater than in other tumors. The origin, development, structure, and growth characteristics must be taken into consideration with their histologic morphology to distinguish the different types and to plan the treatment.

Malignant adenoma constitutes 90 per cent of all malignant lesions of the thyroid and may present many combinations of morphologic transitions. The combinations cause the difficulty in diagnosis by morphology alone. In 330 cases which were diagnosed as malignant thyroid neoplasms by five different pathologists up to

1932 at the Cleveland Clinic, a review that did not depend on morphology alone proved 108 to be non-malignant. The elimination was probably correct, as only four patients of this group are dead, all from some intercurrent disease, whereas of the 78 proven to have malignant adenoma 46 are dead. Errors in the opposite direction may also occur.

The other malignant tumors encountered are adenocarcinoma, scirrhous and papillary carcinoma, carcinoma sarcoma, and sarcoma.

Metastases may be present when not suspected and every patient, before operation, should have an x-ray examination of the chest. Metastases may also occur in the bones and soft tissue.

The treatment should be based upon its known growth characteristics. Only 50 per cent of cases can be diagnosed clinically before operation. When a diagnosis of malignancy can be made definitely, the condition is usually inoperable from a cure standpoint because of the probable invasion of the blood vessels.

When a malignant adenoma is discovered, roentgen irradiation is indicated regardless of whether or not the surgeon believes he has removed all of the growth, since blood vessel invasion is probable. The latter condition speaks against interstitial irradiation. Most of the malignant adenomas are quite radiosensitive. Roentgen irradiation alone has been efficacious. The adenocarcinomas not originating in adenomas are localized and of very low grade malignancy and thus need no irradiation. Scirrhous carcinomas are highly radio resistant and interstitial radiation is best, although prognosis is bad in all forms of treatment.

Papillary carcinoma when discovered by operation, may have interstitial irradiation, to be followed by roentgen irradiation later. The carcinoma sarcomas are highly malignant. The lymphosarcomas are radiosensitive but highly malignant and require radiation in addition to the operation.

The technic of radiation is for radium, either the seeds or needles and for roentgen radiation, 200 K.V. and heavy filtration.

S. M. ATKINS, M.D.

The Treatment of Hyperthyroidism by Roentgen Irradiation of the Hypophysis. J. Borak. *Strahlentherapie*, 1935, 53, 73-89.

During the last ten years the author has treated a series of patients with thyrotoxicosis by irradiating the hypophysis alone or both hypophysis and thyroid. Sixteen patients who had not been treated by any other means received x-ray therapy over the hypophysis alone with 55 per cent cures. Twelve patients, treated first without success over the thyroid, were treated later over the hypophysis with 75 per cent cures. Eight patients partially improved by x-ray therapy over the thyroid were then treated over the hypophysis, with good results in 75 per cent.

The author discusses at length the biologic foundations of this method. He believes that there is probably a reduction of the hormone secretion in the hypophysis which normally has a stimulative effect on the thyroid.

The technic used was as follows: 170 K.V., 0.5 mm Zn, 30 cm F.S.D., 200 r each over two temporal fields and one frontal field, repeated after 8 days, for the thyroid, one anterior and two lateral fields. The series may be repeated after from six to eight weeks.

ERNST A. POHLE, M.D., Ph.D.

TUBERCULOSIS, LARYNGEAL

Roentgenologic Study of Tuberculosis of the Larynx and Neck. Henry K. Taylor and Louis Nathanson. *Am. Jour. Roentgenol. and Rad. Ther.*, November, 1934, 32, 589-607.

Roentgen examination of the larynx is valuable because it makes possible the determination of early lesions within the ventricle which might be missed on mirror examinations.

Earlier workers in the field of laryngeal tuberculosis have emphasized the "washed-out" appearance of the cartilages and infiltration of the soft tissues. Pancoast and Pendergrass feel that there may be no roentgenologic distinction between tuberculosis, syphilis, and tumors in cases in which obliteration of the laryngeal ventricle is demonstrated. Tuberculosis has been described by some as the commonest specific lesion affecting the larynx; the lesion rarely manifesting itself as tuberculoma.

The pathology of laryngeal tuberculosis is in the nature of infiltration, edema, ulceration, tumor formation, and perichondritis. The order of frequency of involvement of the various laryngeal structures is the interarytenoid space, arytenoids, vocal cords, ventricle and ventricular space, aryepiglottic folds, and epiglottis.

The authors' technic is: Patient sitting, head erect, neck in true lateral position, 8 x 10 cassette, double intensifying screens, 55 K.V., 100 ma., 6 ft. distance, exposure time $\frac{1}{20}$ or $\frac{2}{10}$ second. One exposure is made with the larynx at rest and the other during phonation, employing a high pitched E sound. When the thyroid cartilages show considerable calcification, oblique positions are also used. Fluoroscopy is likewise an essential part of the examination for determining mobility of the arytenoid eminences as well as the larynx as a whole. The act of swallowing, both with and without barium, and the act of phonation are observed during this part of the examination.

The authors recognize that at the present time roentgenologic examination of the soft tissues of the neck may not always afford absolute differentiation of the hyperplastic (neoplastic) and the ulcerative (inflammatory) lesions. However, the x-ray examination supplements the available clinical data and is a valuable record which should be made prior to the clinical examination. Small lesions situated deep in the interarytenoid area are most easily shown in the x-ray examination, on the other hand, lesions deep in the ventricular fold may be well shown roentgenologically but missed by the mirror examination.

In the series of 100 cases studied by the authors the majority of the patients (93) had a caseous pneumonic or malignant type of tuberculosis. Of these 93, 15 had minimal laryngeal lesions; 53 had moderately extensive

lesions, and 25 had extensive laryngeal lesions. Eight of these 100 cases of laryngeal tuberculosis had no laryngeal symptoms.

In contradistinction to syphilis and malignancy, tuberculosis in the early stages attacks the posterior portion of the larynx, involvement seems more marked on the laryngeal surface and there is a minimal amount of distortion of the normal anatomical relationships. Tuberculomas were rarely encountered in this series.

Roentgen examination gives a permanent graphic record of the location, the extent, and progress of the lesion.

J E HABBE, M D

TUBERCULOSIS, PULMONARY

Some Observations on the Roentgen Therapy of Tuberculous Laryngitis and of Pulmonary Tuberculosis. Bruno Faccini. Arch di Radiol, September-October, 1934, 10, 564-573.

Faccini states that laryngeal and pulmonary tuberculosis are frequently co-existent, but that the latter is demonstrable only on roentgenographic examination. He divides his cases of laryngeal tuberculosis into two groups, the exudative and the productive types, and subdivides them according to whether they are ulcerative or infiltrative. He discusses briefly the development of x-ray techniques applicable to these lesions. The author has treated 40 cases in eight years with encouraging results.

E T LEDDY, M D

TUMORS (DIAGNOSIS)

A Case of Intrathoracic Neurinoma. G M Reviglio. Arch di Radiol, 1935, 11, 29-35.

The author gives the history of a patient aged 6 whom he has followed up for four years and in whom the presence of an intrathoracic tumor was discovered accidentally by x-ray examination during an attack of influenza. The roentgenographic characteristics of the lesion are illustrated and discussed in detail.

E T LEDDY, M D

TUMORS (THERAPY)

Primary Newgrowths Involving the Hand. Bernard F Schreiner and William H Wehr. Am Jour Roentgenol and Rad Ther, October, 1934, 32, 516-523.

At the State Institute for the Study of Malignant Disease at Buffalo, N Y, approximately 1 per cent of all malignant tumors involved the hand, the total being 128 of 11,212 cases reviewed. The most common was squamous cell, 101, and next basal cell, 20.

The superficial processes are curable by irradiation, the more extensive lesions with tendon involvement but no demonstrable metastases are sometimes healed by irradiation, but amputation must be resorted to in many of these cases. In far advanced lesions or in small ones showing definite metastases of the lymph-bearing areas, treatment by irradiation or surgery or the two combined proved to be only palliative.

S M ATKINS, M D

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A BIOLOGICAL MEASUREMENT OF RADIUM GAMMA RAYS

By FRANK M. EXNER, M.A., and CHARLES PACKARD, Ph.D., New York City

From Columbia University, Institute of Cancer Research, Francis Carter Wood, M.D., Director

ATTEMPTS to express gamma-ray dosage in terms of the roentgen have thus far yielded discordant results. Some investigators have approached the problem by endeavoring to determine the ionizing effect of the gamma rays in air. Direct measurement of this effect by means of the standard open chamber and thin-walled chambers (3, 11) has largely given place to indirect methods, such as calculation from determinations of the total gamma-ray energy per gram of radium, calculation by means of Eve's constant, and the measurement of the ionization produced in a small volume of air enclosed within an irradiated solid, such as a thick-walled thimble-type chamber. Some of these results have been collected by Sievert (17) and Friedrich (4). The numbers of roentgens corresponding to one milligram-hour of radium obtained in these various ways differ greatly among themselves. The open chamber gives values in the neighborhood of 2-3, while indirect methods give values between 8 and 11 r/mgm-hr. The values given by open chambers have been shown to be too low (1, 11) for a reason which will be mentioned later.

All the figures that have been mentioned refer to the intensity of radiation, filtered through 0.5 mm of platinum, at a distance of 10 cm from a point source. The results obtained in experiments in which different filtrations and distances are used are custom-

arily reduced to these or other standard conditions, for without such reduction they cannot be compared with each other.

In addition to these methods involving the ionization of air, mention should be made of an interesting procedure recently reported by Taylor and Mohler for determining the total ionization produced by absorption of radiation in a liquid. A preliminary value of 6.9 r/mgm-hr has been obtained by this method (19).

A biological method of approaching the problem involves a comparison of the magnitude of the reaction produced by both gamma rays and x-rays in a living test object. When the effect of a dose of gamma rays is the same as that brought about by a measured dose of x-rays, the two doses have been assumed to be equal (2). In order to avoid the assumption that the roentgen thus determined biologically is actually the same as that defined in terms of ionization, it is convenient to agree that a dose of gamma radiation which produces the same amount of biological effect as one roentgen of x-radiation shall be called, as Failla suggests, an "equivalent roentgen" or, as possibly more descriptive, a "biological roentgen." The values that have been obtained by biological methods, when reduced to standard conditions, range from 4 to 6 r/mgm-hr (2, 8, 13, 16, also data in 7 and 18 reduced to comparable form by the present writers). These results are in

fair agreement among themselves, but they do not agree with those obtained by physical methods. If it were assumed that both sets of values are substantially correct, the conclusion might be drawn that equal doses of α - and gamma rays, measured by their ionization, produce different quantitative effects. Before considering such a conclusion we should discuss in more detail the conditions under which the biological measurements were made, and whether the physical methods have correctly measured air ionization. The latter question will be briefly considered in our concluding discussion.

The difficulties encountered in measuring gamma rays by physical methods have been dealt with by many authors and will not now be discussed except in relation to the biological measurements. On the other hand, little has been said in the literature regarding the choice of suitable physical conditions for exposing small test objects such as *Ascaris* or *Drosophila* eggs to gamma rays.

It may be worth while in passing to re-emphasize the importance of keeping clearly in mind the limited though fundamental significance of the type of experiment under discussion, in relation to the larger problem of irradiation under deep therapy conditions. In the experiments considered in the present article the object is to study the biological effect of α -rays or gamma rays in relation to other information about the *absorbed* radiation. For this purpose the experiment is simplified by allowing the test object to absorb energy, so far as possible, from only the direct rays emerging through the filter, avoiding absorption of radiation of uncertain amount and quality scattered by extraneous objects. Under these conditions, by means of known absorption data the absorbed energy and hence the biological effect can be related to the intensity and quality of the incident radiation. In marked contrast to this simplified experimental procedure is the irradiation of tissues under deep therapy conditions. In the latter case there is no simple relation

between the amount and wave length of the absorbed radiation and the rays incident on the extended absorbing and scattering medium in which the tissue is located. The question of this latter relation in any particular case must be answered before the results of the former type of experiment can be applied. Lauritsen has called attention (10) to the confusion which has arisen in certain cases in which statements about the relation of biological effect to the wave length of the *absorbed* radiation have been misapplied to questions involving the influence of the wave length of the *incident* radiation on the transmission of the energy through an extended medium.

EXPOSURE CONDITIONS FOR SMALL TEST OBJECTS

Source and Filter—In experiments of this type the radiation has usually been obtained from an extended source with dimensions comparable to the distance between the source and the test object. Under these conditions it may be difficult to take accurate account of the variable distance and filtration applying to the test material for rays coming from different parts of the source. The early radium measurements by one of the present authors were affected by this source of uncertainty (16). This difficulty can be avoided in large measure by the use of a spherical filter and applicator enclosing at its center a small bulb of radon which acts as a point source.

Scattered Radiation—Another matter to be considered in planning exposure conditions is the effect of scattered gamma radiation.

The thin filters used in biological experiments absorb only a small fraction of the total radiation from the source and so scatter a still smaller fraction (less than 10 per cent for 1 mm platinum). The effect of this scattered radiation on the test object is always included with the direct rays as part of the effect to be measured. The amount of this scattering which reaches

geometrical arrangement of source, filter, and test object. However, with arrangements suitable for the present type of experiment, variations on this account are small enough to be unimportant unless the precision of the experiment approaches 1 per cent as in the present investigation. The use of a small spherical filter puts this factor under definite control.

A lead or platinum filter also emits a certain amount of fluorescent radiation, but this can be shown by calculation to be responsible for less than 1 per cent of the energy absorbed by a test object composed of light material.

The effect of scattering by objects other than the filter should be reduced to a negligible amount in experiments of the present type. Rather than attempt an exact calculation of the scatter from surrounding objects with the arrangement used, it is simpler to adopt conditions such that an upper limit small enough to be neglected can be calculated on simplified assumptions such as isotropic scattering without change in wave length. A picturesque way of delimiting a danger zone to be kept clear of substantial scattering objects, with a large factor of safety, is to imagine the radio-active material from the source to be transferred to a point on a spherical surface drawn around the test object. By inverse square law a radius for this spherical surface can be specified such that the intensity at the test object will be any desired fraction of the intensity when the radio-active material is in its proper position. This fraction will certainly be much greater than the effect, on a test object composed of light material, of back-scattering by all matter more remote than the distance thus specified. For example, if the test object is 1 cm from a point source, the effect of radiation scattered from all objects over 10 cm away will be less than 1 per cent of the effect of the direct rays.

Secondary Beta Radiation—Of greater importance are the effects connected with the long range of the secondary beta radiation. It has been mentioned that in

comparing the results of exposure of different test objects to gamma rays the various conditions of irradiation are usually reduced to standard conditions. This is done by applying both the inverse square law of distance from a point source, and data expressing the absorption of gamma rays in the intervening material. This procedure involves the tacit assumption that the effect produced in a cell is determined by the flux density of gamma radiation in the region occupied by that cell. But actually, the effect on the cell under consideration is determined by the flux of gamma radiation not only through the cell but also through a region surrounding the cell to a distance of millimeters in tissue, or of meters in air. The reason for this is that the biological response depends, not on the gamma rays directly, but on the long range secondary beta particles produced when gamma radiation is absorbed. This situation is very different from that which obtains when low voltage x-rays are used. In the latter case the ionizing secondary electrons or beta particles produced in a cell have a range which may be small compared to the diameter of the cell. Therefore secondary betas produced outside will not be able to enter the cell and the observed effect is almost entirely due to secondary betas which originate within the cell itself. Consequently the presence or absence of small amounts of material, such as a celluloid plate or strip of gauze used to support the cell during exposure, is unimportant. In the case of low voltage x-radiation, therefore, it is justifiable to relate the observed result to the x-ray energy absorbed in the cell itself.

It is evident from what has been said that a mere statement of filtration and distance from a point source is not sufficient to determine unambiguously the beta-ray activity produced in a test object by gamma radiation. Strictly speaking, a complete description of the distribution and composition of all material in the neighborhood from which beta particles can pass to the test object is needed. The obvious way to avoid most of the diffi-

culties resulting from this situation is to immediately surround the test object with a layer of tissue-like material which is which the beta-ray energy is emitted. At first sight it might seem, since most of the beta particles arriving at the test object are

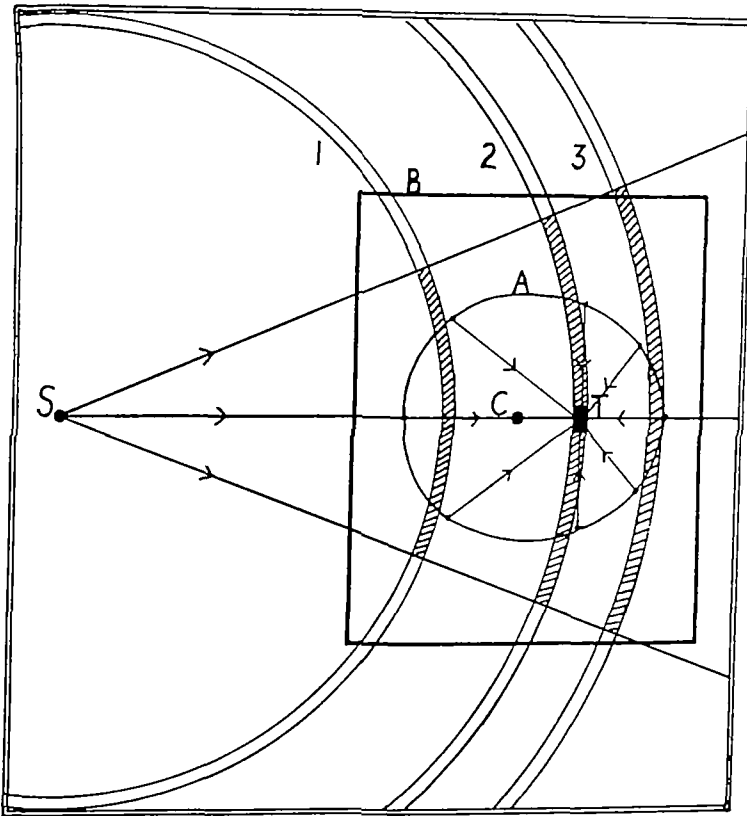


Fig 1 Schematic representation of "active region" (S) Filtered point source (T) Test object such as a cell embedded in a block of tissue-like material with boundary B (A) Boundary of active region such that no appreciable amount of secondary beta radiation can reach T from points outside this boundary (C) Center of absorption with respect to beta production in T

thick enough so that the "active region" contributing beta particles in appreciable amount to the test object is restricted to this envelope, whose properties can readily be specified. In this way the complicated process of conversion of gamma rays to beta particles, insofar as it affects the cell, is confined to a limited region such that the beta-ray activity produced in the cell will depend on the gamma radiation which is absorbed within this region only.

Figure 1 shows schematically such an "active region" surrounding a test object, T. The unsymmetrical configuration about the test object is a consequence of the predominantly forward direction in

produced in the side of the active region toward the source, that the beta activity at the test object would be a measure of the gamma-ray intensity at some other point, C, which might be called the "center of absorption" of the active region. But since most of the beta particles are moving in the forward direction it is approximately correct to regard the flux of beta radiation which accompanies the gamma-ray beam as diverging from the source along with the gamma flux. Thus the beta rays produced in Zone 1 (Fig 1) by gamma rays of intensity I_1 will have spread out in passing to Zone 2 to correspond to gamma intensity I_2 at this

position. However, the lateral compensation which was effective in this case will not suffice to bring about a radial concentration of the backward moving betas produced in Zone 3 into Zone 2. This would require a mechanism analogous to specular reflection. But in view of the small proportion of backward moving betas and the small radial distance involved, their disturbing influence on the divergence of the beta flux may be neglected. Likewise the attenuation of the gamma radiation by absorption in the material lying between the "center of absorption" and the test object, being much less than 1 per cent may be left out of account for practical purposes.

Thus it is seen that if a test object is immediately surrounded by a layer of similar material at least as thick as the effective range of secondary betas, the beta activity in the test object due to gamma rays from a point source will be to a sufficient approximation proportional to the flux density of gamma rays at the test object, and will follow the inverse square law of distance from the source.

The condition just described corresponds exactly to the situation of a cell in the body not too near the surface. Therefore, experimental results obtained under such conditions will, in that respect, be applicable for therapeutic purposes.

It is interesting to note some of the errors which have been made when such a simplified beta-ray contributing region has not been used. It has been mentioned that attempts at measuring free air ionization of gamma rays, using open ionization chambers, have given values less than one-third of those obtained by other methods. In this situation the relation between gamma-ray conversion and beta-ray absorption and scattering which result in a certain ratio of beta- to gamma-ray activity in a freely diverging beam, are completely upset by the presence of the diaphragms used to define the narrow beam required in this type of measurement (1, 11), resulting in ionization values one-third to one-fourth as large

as those obtained from thimble-type chambers.

It is hardly to be expected that such large differences should be found between the results obtained with any one of the experimental arrangements ordinarily used with living test objects. These objects are always exposed within a very few centimeters of the source of radiation, and there is little or no effective diaphragming. But puzzling complications are likely to occur even when working with undiaphragmed radiations, if the test object is not surrounded with sufficiently thick walls to exclude beta particles originating outside the wall material. By way of illustration, we may compare some measurements by Glasser (5) with those of Workman (20) and Albrecht (1). These latter, using diaphragmed beams and drum-type chambers, found that a wall thickness of about four millimeters of carbon is needed to build up full beta-ray equilibrium. On the other hand, Glasser, using an undiaphragmed radium source with 0.5 mm platinum filter, exposed, at an unspecified distance, a thimble chamber with walls of variable thickness composed of "Luftmasse". The chamber was mounted on a thick metal stem. He found that with increasing wall thickness, the ionization reached a maximum at 1 mm and concluded that this thickness is sufficient for an "air wall" chamber. On the other hand, Friedrich, Zimmer and Schulze (4), also using a thimble-type chamber, but avoiding the effect of secondary beta radiations from the filter, found that ionization increased with wall thickness up to 4 mm of carbon. In agreement with Albrecht and Workman, these latter workers found a deficiency of the order of 30 per cent for a 1 mm carbon wall. Since the equilibrium beta-ray emission from platinum is about 25 per cent less than for carbon (for low gamma-ray filtration), one might thus expect an increase of the order of 6 per cent in going from 1 mm to 4 mm under Glasser's conditions. Presumably this was masked by some unrecognized compensating effect. In this connection it is

noteworthy that the ratio of 1 per mg-hr obtained by Glasser and Mautz, using 0.5 mm Pt filter, is 7 per cent larger than

This is due to the additional photoelectric absorption of the gamma rays in heavy elements which more than compensates for

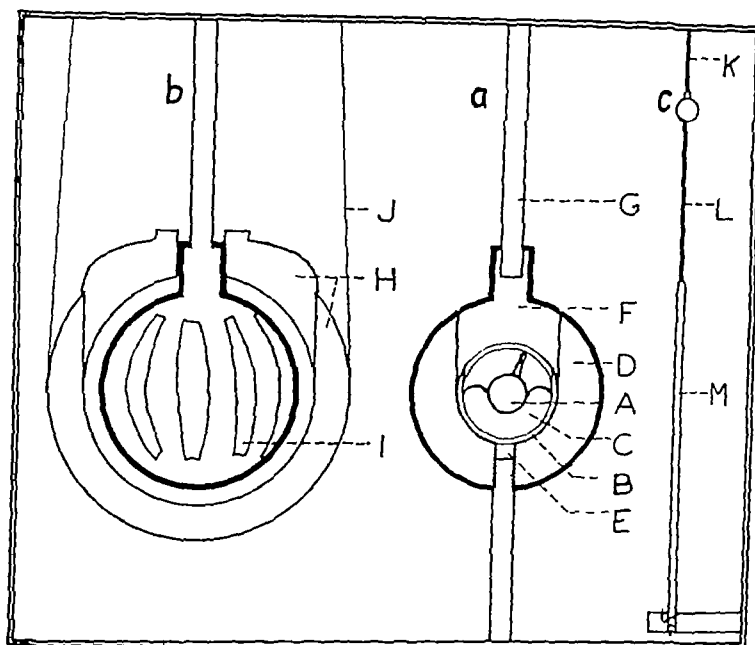


Fig 2 Spherical applicator 2-a (A) Spherical glass bulb 3.5 mm in diameter containing radon. The seal-off tip is shown projecting upward (B) Spherical filter of platinum-iridium 0.5 mm thick, 9.2 mm outside diameter, consisting of two closely fitting sections machined from solid bar (C) Paraffin with a central cavity to hold the radon bulb (D) Sphere 18.7 mm in diameter, machined from black bakelite and fiber composition, density 1.30 gm/cm³. The wall is 4.7 mm thick. A threaded hole E receives a wooden splint 2 mm in diameter for handling and supporting the sphere. The material was found by a competent analyst to contain hydrogen 6.7 per cent, carbon 62.0 per cent, remainder oxygen 31 per cent residue after combustion in oxygen 0.33 per cent composed chiefly of iron oxide (F) Bakelite plug to which the upper section of the platinum sphere is attached with cement. The plug and platinum sphere can thus be lifted bodily out of D by means of the wooden splint G.

Fig 2 b (H) Shell 3.5 mm thick and 22 mm inside diameter enclosing the bakelite sphere described under Fig 2-a. The shell is made of the same material as the sphere. (I) Lens shaped slips of moist filter paper adhering to the sphere and carrying the eggs. (J) Supporting loop of thread.

Fig 2 c Shows the method of supporting the sphere in the tests in which the outer shell was not used. (K and L) Wooden splints 2 mm in diameter and 15 cm long. In the exposures made in the small room L was only 0.3 cm long. (M) Wooden rod 33 cm long 6.5 mm diameter.

that of Glasser and Seitz who used 2.0 mm of brass (5). The fact that the ionization produced in their chambers was partly due to secondary beta rays originating in the filters might well explain this difference. With lightly filtered gamma radiation, the secondary beta emission in the forward direction is greater for heavy elements such as platinum than for materials of medium atomic number, such as brass

their stronger nuclear scattering of beta particles. This difference amounts to some 15 per cent (20).

The secondary beta radiations originating in the platinum filter were presumably responsible for a large part of the effect noted by Braun (2) in his measurement of gamma-ray intensity by means of *Ascaris* eggs. Apparently using the experimental arrangement of Zuppinger (21), he placed

a platinum needle on the celluloid plate which carried the eggs. It has been mentioned that the beta emission in the forward direction is greater than platinum than from brass. But also it is some 25 per cent less than from the light elements composing tissue, for which the nuclear scattering effect is small. Hence the eggs should have received a measurably larger effect if the platinum needle had been covered with a few millimeters of light material. In addition to beta rays from the platinum needle, the eggs received beta rays originating in and reflected from the celluloid plate on which they were placed, and from the air, the furniture, and the walls of the room. To interpret fairly the result of such an experiment it would be necessary to evaluate the relative importance of all these contributing effects. On the other hand, in the applicator used by Simon (18) the "active region" surrounding the test material is practically restricted to a layer of hard wood 1 cm thick. But the large extent of the source in comparison to the effective working distance makes accurate reduction to standard conditions difficult.

These illustrations serve to emphasize the advantage of closely surrounding all test materials used in experiments with gamma rays by a zone of tissue-like material of a thickness at least equal to the effective range of the secondary beta particles. Only under these conditions can the observed effect be directly related to gamma-ray intensity without a careful consideration of the importance of disturbing effects connected with the particular conditions of the experiment. It may be remarked in passing that this requirement is now recognized as essential in the use of small ionization chambers in which the wall effect is utilized (4, 11, 20).

EXPERIMENTAL

Many of the difficulties mentioned in the introduction can be avoided by using an applicator having spherical symmetry. If this has a radius of 1 cm and a spherical platinum filter 0.5 mm in thickness, the

standard conditions are realized, and the results are obtained directly. Furthermore, by the addition of a close-fitting shell which surrounds the sphere, the simplest possible conditions for gamma-ray conversion are obtained. The test material receives the full beta-ray activity in equilibrium with symmetrically diverging gamma rays in a material which is comparable to tissue.

DESCRIPTION OF APPLICATOR

The applicator consists of a bakelite sphere containing a platinum filter and radon bulb. Its construction is shown in Figure 2, details, including the atomic composition of the bakelite, are given in the caption. The thickness of the bakelite between the filter and the test material is 4.7 mm. According to Workman (20) and Albrecht (1), this thickness is sufficient to ensure that practically all beta radiation which affects the eggs is the result of absorption of gamma rays in the bakelite. It also follows from Workman's results that the 3.5 mm of bakelite in the shell is sufficient to give the limiting contribution of reflected beta rays. Thus the active region from which beta radiation is received by the eggs is restricted to the adjoining bakelite, the interstice in which the eggs are placed being so thin as to have no appreciable disturbing effect. The radius of the sphere was made somewhat less than 1 cm to allow for the thickness of the filter paper on which the eggs lie. The diameter of the sphere was accurately determined with a short focus telescope mounted on a calibrated measuring screw, and checked with a micrometer caliper. Slips of filter paper with eggs were then placed on the sphere, as if for an exposure, and the average position of the mid-point of several eggs from the opposite side of the sphere determined by means of the telescope. The diameter of the sphere alone was 18.67 mm. The distance of the mid-point of the eggs above the surface was 0.33 mm. The distance from the center of the sphere to the eggs was thus 9.67 mm, with a probable error of ± 0.03 mm. To

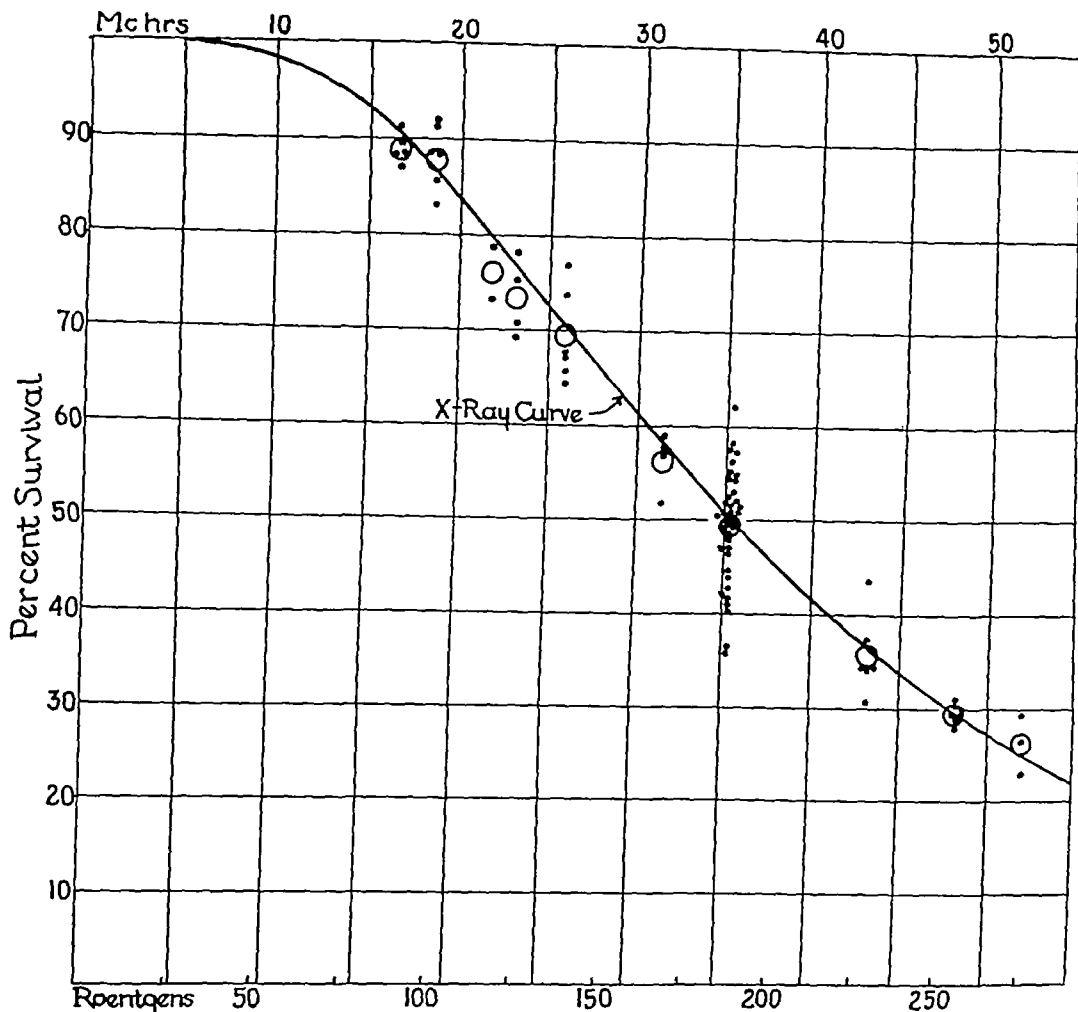


Fig 3 Survival data for *Drosophila* eggs exposed to gamma rays. The curve is based on data from previous x ray experiments. The symbols represent the results of the present experiments with gamma rays. The open circles represent the averaged percentage survival of each group of tests; the small solid circles the percentage survival of individual exposures.

reduce the results to 1 cm diameter the correction factor is 0.934 ± 0.006 .

The small size of the radon bulb in relation to the platinum filter is important. As may be seen in Figure 2 the greatest obliqueness with which a ray can pass through the platinum shell is insufficient to cause any serious difference in filtration. The effect of the average obliqueness will be imperceptible.

THE TEST OBJECT

The eggs of the fruit fly, *Drosophila melanogaster*, were used as a test object in these experiments, for their quantitative response to radiations is more constant

than that of any other biological material. A detailed description of the technique involved is published elsewhere (14, 15). The eggs, on slips of black filter paper, are given the desired dose of radiation and then incubated at room temperature ($22-25^{\circ}\text{C}$). It should be emphasized that if the results of other experiments are to be compared with these, the exposures should be limited to a duration of not more than 25 minutes, and the intensity should not be less than 5 r/min. On the day following the exposure, those eggs that have already hatched are counted. There are always a few of these which were old when laid, and therefore they should be excluded. On

the next day the samples are counted, and the proportion of survivors determined. The result thus obtained is corrected to allow for the fact that in the control samples some eggs are infertile, or fail to hatch out as larvæ. Since the average fertility of the controls is 97 per cent, the actual percentage of survivors is divided by this amount.

Careful study has demonstrated that there is a definite relation between the dose of x-rays and the proportion of eggs that hatch. A dose of 190 r results in a hatching rate of 50 per cent, regardless of the wave length of the incident beam. The wave lengths thus far tested range from 0.05 to 1.6 Å (14). The curve shown in Figure 3 indicates the relation between dose and effect as obtained with x-rays. At the bottom of the figure is a scale showing doses in roentgens, the percentage of surviving eggs is seen on the ordinate. By drawing an ordinate up from any point on this scale to meet the curve, the quantitative effect of such a dose can be found. Statistical analysis of data derived from 200 experiments with x-rays shows that the average deviation in the percentage of survival of a single test from the expected point on the curve is 2.54. The standard, or root mean square deviation of a single test, is ≈ 3.10 . When the same carefully measured dose is given to several different lots of eggs, the averaged percentage of survivals lies very close indeed to the curve, the deviations averaging less than 2. These figures are presented in order to demonstrate that results obtained with *Drosophila* eggs are

precise when the tests are performed with the proper technique.

The curve shown in Figure 3 is used as a means of measurement. For if the survival rate of the eggs is determined with such precision by the dose, then, conversely, the dose can be determined with equal precision by the survival rate. Data illustrating this point have been presented elsewhere (14, 15). Thus if after irradiation, it is found that 65 per cent of the eggs hatch out as larvæ, the curve indicates that the dose must have been approximately 165 r. In Table I the doses thus measured are called "biological roentgens" to distinguish them from doses measured by a dosimeter.

The eggs were placed on small lens shaped pieces of black filter paper which when moistened with banana juice, lie smoothly on the surface of the sphere, as shown in Figure 2. Exposure commenced when the plug carrying the radon and filter was inserted into the sphere. In those tests in which the shell surrounded the sphere, all of the eggs received the same dose. The exposure was terminated by withdrawing the radon. In other tests in which the shell was not used, the slips with their eggs were removed, one or more at a time, after the desired exposure, as indicated by a stop-watch, had been given. The temperature during these experiments varied between 22.0 and 24.7° C.

On the first two days of the experiment the sphere, supported as shown in Figure 2-c, was mounted on the end of a light board projecting 20 cm over the edge of a flat-topped wooden desk. The applicator

TABLE I

Without Shell	Dose	Alive	Dead	Percentage Alive	Corr	Biol r	r/mc hr
Large room	25.93 mc hr	139	72	65.9	67.9	143	5.51
		124	40	75.6	77.8	120	4.65
		154	76	65.2	67.2	144	5.55
					71.0	136	5.24
Small room		137	82	62.6	64.5	151	5.82
		167	64	71.7	73.9	127	4.96
		112	62	63.8	65.7	148	5.71
					68.0	143	5.51

was 108 cm above the concrete floor of the room, 135 cm from a brick wall, and about a meter from wooden partitions, shelves, and tables. In the exposures with the shell the applicator was hung by a thread in the same position. To make sure that the experiment was not affected by the surrounding objects the remaining tests were carried out in a large room cleared of all objects so that the applicator was surrounded in every direction by at least two meters of air except for a concrete beam 160 cm overhead and a horizontally supported long thin wooden stick on the end of which the applicator support shown in Figure 2-c was placed.

The radon was obtained from the Memorial Hospital, New York City, through the courtesy of Dr G. Failla. A preliminary measurement of its activity permitted the preparation of an exposure time schedule before the experiment began. The results of tests made in previous years with another type of applicator provided a basis for determining the approximate doses in mc-hr which should result in survival percentages ranging from 90 to 25. The exposure schedule was adjusted for the decay of the radon before each test. Exposures which varied from 2 to 20 minutes in length were made on five different days.

An accurate measurement of the amount of radon was made after it had decayed to a value comparable to the 50 mg radium standard used at the Memorial Hospital. From this, the quantity at the beginning of the experiment was found to be 446 mc. The decay constant used in calculating this value is $2.097 \times 10^{-6} \text{ sec}^{-1}$.

All of the data obtained in six tests are given in Table I as an example of the method of calculating the values of $r/\text{mc-hr}$. In these tests, which were made on three different days, the dose was 25.93 mc-hr. The numbers of living and dead eggs are shown, with the actual and the corrected percentage of survivors. Under the caption 'biological r ' appear the number of roentgens which on the curve correspond to each individual survival

TABLE II

	With Shell	Without Shell
	$r/\text{mc-hr}$	$r/\text{mc-hr}$
Large room	4 41 5 23	4 42 5 34
	4 75 5 26	4 53 5 39
	4 81 5 46	4 65 5 46
	5 00 5 52	4 81 5 51
	5 03 5 63	4 96 5 55
	5 23 5 83	5 00 5 57
		5 03 5 57
		5 09 5 62
		5 23 5 62
		5 27 5 62
		5 32 5 60
		5 34
Small room	5 00 5 89	4 83 5 42
	5 21 5 97	4 89 5 44
	5 26 6 00	4 96 5 46
	5 32 6 14	5 02 5 51
	5 32 6 20	5 04 5 55
	5 40 6 60	5 18 5 71
	5 47 6 65	5 23 5 77
	5 66	5 26 5 82
		5 34 5 85
		5 34 5 86
		5 36 5 87
		5 38 5 96
		5 39 6 00
Average	5 49 $r/\text{mc-hr}$	5 35 $r/\text{mc-hr}$
Stand dev	0 530	0 366
P E _m	0 069	0 036
	Total average	5 40 $r/\text{mc-hr}$
	Stand dev	0 436
	P E _m	0 034
	Corrected value	5 00 $r/\text{mc-hr}$

rate. The ratios of r per mc-hr, seen in the final column, are obtained by dividing the number of biological roentgens by the dose in mc-hr. The percentage of eggs surviving in the 76 tests which have been made with the present applicator are shown in Figure 3.

RESULTS

In Table II are presented the ratios of r per mc-hr obtained in all of the 76 tests. The results of the experiments made with the shell and without it are shown in separate columns. Both sets of data are further subdivided according as the tests were made in the large or in the small room. The averages show that the number of $r/\text{mc-hr}$ obtained when the eggs are enclosed in the bakelite shell is greater than that obtained when the shell

is absent. The difference amounts to 2 per cent, with a probable error for the difference of 1.5 per cent. Under the conditions of this experiment the effect of the shell should correspond approximately to that of the "back wall" in experiments with a drum-type chamber. Workman (20, Fig. 3), using such a chamber, found an increase of 5 per cent due to the presence of a thick back wall of carbon. The present results, while not definitely indicating an increase with the shell, allow a chance of one in five that an effect of the magnitude found by Workman was present.

Between the mean values obtained in the large and small room the difference is greater, being 6 per cent, with a probable error for the difference of 1 per cent. On a purely statistical basis, such a difference would be regarded as significant, but careful examination of the exposure conditions in the two rooms fails to reveal any experimental basis for the discrepancy. As was explained in the introduction, the scatter from surrounding objects was a small fraction of 1 per cent of the total effect in either case. Therefore, it was decided to regard the observed difference as an unusually large accidental error and to take as the most probable value of the result the unweighted average of all the exposures made in both rooms, with and without the outside shell surrounding the applicator. The total average of all of the experiments indicates that the ratio of r per mc-hr is 5.40 when the radiation is a point source, the filter 0.5 mm of platinum and 4.7 mm of bakelite, and the distance is 9.67 mm. Multiplying this value by 0.934 to reduce to 1 cm distance, and further deducting 1 per cent to allow for the true absorption in bakelite the final value becomes 5.00 r /mc-hr.

Thus far no mention has been made of the percentages of eggs hatching in the various tests. These are shown in Figure 3. At the top of this figure is a scale of mc-hr from which the actual doses given to each group of tests can be determined. It is evident that the averages lie very close to the curve especially when the group

consists of many individual tests. The figure also illustrates the amount of variation which may be expected in experiments carried on under these conditions. These variations are somewhat larger than those met with in α -ray tests, due perhaps to the fact that the centering of the radon bulb may have been inaccurate by as much as 0.3 mm. This might introduce deviations of a maximum of about 6 per cent in the dose received by the individual slips bearing eggs. But since these were always symmetrically placed on the sphere, the final average would not be affected.

The range of variation in the values of r /mc-hr obtained in the separate tests is indicated by the standard deviations shown in Table II. When the individual deviations from the average are examined, it is seen that two-thirds of the total are not greater than the standard deviation, while 94 per cent are not greater than twice that amount. Thus the frequency distribution closely follows the normal error curve.

DISCUSSION

The ratio of r per mc-hr obtained in the present experiments under specially favorable conditions, lies in the middle of the range of values previously obtained by biological methods,¹ and very much below the values determined by the physical methods which have been mentioned. Before remarking on the significance of this difference, we must comment briefly on these physical measurements.

¹ In an article by den Hoed (7) which has appeared since the completion of the present manuscript some exposures of *Drosophila* eggs to radium gamma rays and to α rays are described. In the gamma-ray exposures the eggs were exposed to the excessive secondary beta radiation from the lead filter. This error was to some extent counteracted by the fact that in reckoning the dosage the radium tubes were treated as point sources. Of the four radium exposures only one fell on the portion of the survival curve which is steep enough to be used for comparison. This exposure cannot be compared with our survival curve because the author used eggs with a different average age and, therefore, different sensitivity. But plotting his data for 200 kv α rays and comparing the gamma ray exposure with these gives a value of 5 r /mgn-hr in agreement with our result.

It has become almost customary to assume that measurements made with thimble-type ionization chambers having walls of light material of sufficient thickness, represent the ionization that would be produced in free air by gamma radiation. A theoretical discussion by Gray (6) has been regarded as support for such a conclusion. But on the basis of Gray's treatment, chambers of equal volume, and with walls composed of any material in which the photoelectric effect is negligible, should give the same ionization. However, Albrecht (1), measuring ionization in chambers having thick walls of aluminum and of an organic material (cellophane), found that the ionization in aluminum walls was 100 per cent greater than in cellophane. On the other hand, Keller (9), who also used thick-walled chambers, found not more but less ionization with aluminum than with a phenol-formaldehyde resin (*Leukorit*)². And even with thick walls of the same material, substantial differences have been obtained, as illustrated by the recent determinations of the r/mg-hr ratio in thick-walled carbon chambers by Mayneord and Roberts (11), who found a value of 8.3, and Friedrich, Zimmer, and Schulze (4), who obtained a value of 11.2 r/mc-hr. It seems likely that the explanation of some of these effects is to be sought in connection with the very rapid increase, with atomic number, of the importance of nuclear scattering of beta particles. In view of such discrepancies, and of the fact that the physical values are all obtained by indirect means, it seems advisable to reserve judgment as to the meaning of the difference between the results obtained by physical and biological methods.

Until the meaning of physical measurements of gamma radiation can be further clarified, it seems reasonable to take the view that the processes which determine the response of the gg to gamma radiation are more nearly representative of the

biological processes involved in therapy than is the production of ionization through the wall effect of small chambers.

We wish to thank Dr G Failla, of the Memorial Hospital, for his kindness in supplying and measuring the radon needed in this work, and also for his collaboration in the mechanical design and construction of the applicator.

SUMMARY

Some of the conditions leading to uncertainty in the interpretation of the results of the biological measurement of gamma-ray intensity are analyzed. An applicator designed to avoid these conditions is described. Using *Drosophila* eggs as a test object, the number of "equivalent" or "biological" roentgens per mc-hr is measured at a distance of 1 cm from a point source, with 0.5 mm platinum filter. The value obtained was 5.00 r/mc-hr. This result is to be compared with values ranging from 8 to 11, obtained by indirect physical methods.

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² On the other hand Murdoch and Stahel (12) in an article which has just appeared obtain very nearly the same ionization in thick walled chambers of ebonite, paper, aluminum and copper. Their value of 8.11 r/mgm-hr agrees closely with Mayneord and Roberts

RADIOTHERAPY OF SARCOMA OF THE SOFT PARTS

(ON THE BASIS OF STATISTICAL ANALYSIS)

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NO OTHER group of tumors includes tissues as widely divergent in their radiosensitivity as the sarcoma group. With the highly radiosensitive lymphosarcoma at one extreme and the radioresistant sclerosing osteosarcoma at the other, one may arrange on the basis of degree of radiosensitivity a scale of the sarcomas which would be nearly as extensive as the scale of radiosensitivity of neoplastic tissues as a whole. This behavior is a natural sequence of the morphologic and especially histogenic characteristics. For, although the general term of "sarcoma" implies pathologically a malignant tumor composed of cells of the connective tissue type and thus in appearance a rather uniform group of tumors, when further elucidation of the nature or origin of the cells is attempted, the variation is found to be exceedingly great. Since the effect of radiation, in a general way, depends on the susceptibility of the cells or tissues irradiated, and since this function, in turn, is the result of many criteria intimately associated with morphologic and histogenic characteristics, obviously the wide difference in type and origin of the cells leads, with some exceptions, to a like difference of radiosensitivity.

The great radiobiologic and pathologic variation has induced not a few of the investigators to suggest the elimination of the term of "sarcoma," and the separation of the tumors included under its heading into distinct entities of their own. Although such a position cannot be claimed to contribute, for the present, very considerably to the clarification of the problem as a whole nevertheless it clearly indicates the necessity of dividing the sarcomas into subgroups which would permit a better insight into the more or less specific characteristics by paying due

regard to the clinical course at the same time. For this reason, it is proposed that in the following the subject of radiation therapy in sarcoma be treated along identical lines, that is, by discussing the various types of sarcomas, which might constitute a subgroup, individually. There are especially two practical advantages which result from such a procedure. *first*, the technic of irradiation (method, dose, fractionation, etc.) can be considered on the basis of radiosensitivity of each particular type of tumor, and *secondly*, the extent of irradiation can be determined by the known clinical course (extension, metastases) of that specific lesion.

Although the title of the paper suggests that every form of sarcoma, except sarcoma originating from the bone, is considered in the discussion, the subgroups of lymphosarcoma, melanosarcoma, and gliosarcoma were likewise omitted, for they represent such distinct processes that they may best be dealt with separately (7, 13).

STATISTICS

A review of the literature concerning the five-year cure of sarcoma in general reveals the not altogether surprising fact that the problem of radiation therapy still forms a rather favored subject of speculative argumentation. Comprehensive statistical publications are few and because of the indecisiveness as to what really should be included in the group of sarcoma, they are somewhat confused and even contradictory. Thus Rostock (19), in 1928, by collecting 505 cases from eight sources, found that although 78 per cent of the sarcomas responded more or less favorably immediately following radiation, the number of permanent cures was exceedingly small, amounting to only 29 per cent, whereas the purely surgical statistics of Küttner (cited by Rostock), referring to

some 550 cases, indicate a five-year cure of 30 per cent. This, then, would be *prima facie* evidence that surgical intervention must constitute the method of choice in the treatment of all sarcomas and irradiation reserved for the inoperable cases and perhaps prophylactically for some of the more malignant forms operated upon. In his own series of 119 cases, Rostock (19) obtained a 6 per cent cure in the inoperable group (35 cases) treated by radiation alone, a 10.5 per cent cure in the borderline group (38 cases) treated by incomplete surgical removal and post-operative irradiation, and a 37 per cent cure in the operable group (46 cases) treated by radical extirpation and prophylactic irradiation, a fact which would serve only further to confirm the soundness of the above principle. Yet, by analyzing other statistics, we find that there is a very great discrepancy in the percentage of end-results, even by using an association of surgery and irradiation in all instances. Meves (15), for example, in 1931, by reviewing a total of 173 cases, treated between 1914 and 1928, found only 19 cases (11 per cent) which were permanently cured, and even these were mostly mixed tumors and rarely pure sarcomas. He, therefore, makes the statement that a permanent healing of a sarcoma, although possible, must be considered a rarity. de Waard (6) likewise obtained only a 14 per cent cure in 74 cases of operable sarcoma which were treated by surgery alone. Wollner (27) published, in 1926, 12.8 per cent cures in 39 cases of more advanced sarcomas treated by surgery and irradiation, and 28.5 per cent cures in 21 early cases subjected only to radical extirpation. In contradistinction to this, very good results were claimed by Wintz (26) and Hintze (10). The former indicates a percentage of 35 of five-year cures in a total of 367 cases of sarcoma, whereas the results of Hintze, who, in 1930, reviewed a total of 678 cases treated five years or longer before are as follows: (I) of 216 cases treated by surgery alone, 28.7 per cent cures, (II) of 179 cases of recurrence irra-

diated, 39 per cent cures, (III) of 82 cases treated by surgery and prophylactic irradiation, 39 per cent cures, and (IV) of 201 mostly inoperable cases treated by irradiation alone, 24.9 per cent cures. A closer scrutiny of these two latter statistics, however, reveals that several types of tumors are included in the general group of "sarcoma," which we are no longer accustomed to consider malignant, and some of them are not even potentially malignant. Thus in the series of Wintz, as we shall see later, 42 cases (that is, 12 per cent of the total) are uterine sarcomas, an exceedingly rare condition, with a final cure of 57 per cent. In the series of Hintze are included epulis, thus raising the percentage of cures of sarcoma of the jaw to 50, mixed parotid tumors, with cures of 58.6 per cent, degenerated moles raising the percentage of cures in melanoma sarcoma to 47.6, etc. By drawing a sharper borderline between the true sarcoma and its affiliated lesions, the percentage of cures would dwindle down appreciably. Such a procedure would have the additional advantage of leading to a better harmonization of the statistics from the various sources.

A review of the cases treated at Harper Hospital shows that during the period of 1922 to 1929, inclusive, some 3,000 cases of malignancies were dealt with and that, of these, 222 cases were classified as being sarcoma. Conditions now considered as essentially benign, such as benign giant-cell tumor (giant-cell sarcoma) of bone, epulis (giant-cell sarcoma) of jaw, mixed tumors (myxochondro-endothelioma) of parotid, etc., were eliminated from the general statistics of the sarcoma group. In the completion of the final results, all patients who reported to the department, whether or not they received complete treatment, were included, and all those who could not be traced (2.5 per cent) were considered as dead from sarcoma. Likewise, patients who are known to have succumbed to other causes than sarcoma were considered as having died from sarcoma. In this manner, the percentage of from

TABLE I—TOTAL CASES SARCOMA
(Harper Hospital 1922-1929 inclusive 5- to 12 year survival)

I	Bone sarcoma	39	12 5%
II	Lymphosarcoma	31	30 0%
III	Malignant melanoma*	21	85 0%
IV	Melanosarcoma	30	10 0%
V	Sarcoma of soft parts	101	34 0%
	Total	222	30 0%
	(By discounting malignant melanoma)	201	25 5%

* The group of malignant melanomas includes degenerated moles clinically showing signs of active malignancy but in which no biopsy was made to confirm the diagnosis it being our experience that biopsy may be harmful (7)

5- to 12-year survivals for the total group of 222 cases was 30 per cent, and if the cases of malignant melanomas (degenerated mole) are deducted, 25.5 per cent. The results for the individual groups of bone sarcoma, lymphosarcoma, malignant melanoma, melanosarcoma, and sarcoma of the soft parts are shown in Table I. In the group of sarcoma of the soft parts, there were 101 cases with a survival of 34 per cent. This group forms the basis of the present study, and the principles of radiotherapy expounded further below are largely the result of experience gained in connection with its clinical observation and treatment.

It may be mentioned here, in a general way, that irradiation in the cases at Harper Hospital was carried out with the so-called deep x-ray therapy. The quality of the rays used was 0.13-0.14 Å (200 kv, 1-1.5 mm Cu and 1 mm Al as filters), and the quantity varied from 30 to 100 per cent S.U.D. per focus, according to the type of lesion and method of treatment. This latter will be dealt with more *in extenso* when discussing the individual groups of sarcomas.

FIBROBLASTIC SARCOMA

"Fibroblastic sarcoma" is more or less a collective pathologic term which for a while included nearly all of the sarcomas of the soft parts of indisputable connective

tissue origin. In this manner it extended its scope over a wide domain of tumors of rather complex histogenesis. With acquired clinical knowledge, however, this scope gradually narrowed down and groups became detached, as, for example, melanosarcoma, lymphosarcoma, etc., which took up the place of distinct entities. For the past decade, criteria of radiosensitivity began to burrow themselves rather deeply in the field of classification and now we see again there arise new groups, such as myxosarcoma, etc., which possess sufficient characteristic features as to permit their separation from the main group. This process of separation will continue until eventually specific entities will replace the entire group. Histogenetic considerations undoubtedly will play here the greatest rôle.

As it stands at the present time, we include under the heading of fibroblastic sarcoma all those sarcomatous tumors of the soft parts which cannot be placed in any of the well-characterized subgroups. They may arise from almost any location where connective tissue is found—subcutaneous and submucous layers, intermuscular fasciæ, peri- and endomysium of muscles, tendon sheaths, supporting connective tissue of all viscera, etc. Structurally it is customary to divide them into spindle-cell, polymorphous cell, round-cell, alveolar cell sarcoma, etc. Some of them are then further subdivided into large cell and small cell variety, this subdivision permitting certain deductions as to the degree of malignancy and especially of radiosensitivity. In the spindle-cell sarcoma group, which no doubt represents the bulk of the fibroblastic sarcomas, we find, for example, that the large cell variety represents the greatest potentiality of clinical malignancy, with rapid growth, wide local infiltration, and extensive metastases to lungs, lymph nodes, liver, bones, and other organs, whereas the small cell variety shows a somewhat more benign course. Of the latter, a subgroup has been detached under the name of fibrosarcoma, which, except for a marked

procedure is associated with roentgen therapy. If an apparent eradication of the sarcoma has been brought about by the operative method, irradiation is supplemented in a prophylactic manner for the treatment of such regions as are known to form the seat of predilection of eventual metastases, such as the lungs, regional lymph nodes, liver, etc.

In our series (Table II), 61 cases of various types of fibroblastic sarcoma were treated, mostly by a combination of surgery and irradiation, an apparent cure having been obtained in 21 per cent. In some of the cases the disease was quite disseminated at the time of treatment, in others the surgical procedures, consisting chiefly in local excisions, were carried out with great conservatism, so that the favorable results in the group must be ascribed mainly to the radiation therapy.

FIBROSARCOMA, NEUROSARCOMA

The condition that histologically is classified as fibrosarcoma also clinically presents characteristics which make its separation from the ordinary spindle-cell sarcoma group of decided advantage. On the other hand, certain common features were noted with the neurosarcoma, especially as it concerns the histogenesis and radiosensitivity. This induced Ewing, on the assumption that all these lesions are of a neurogenic origin, to create a distinct group, the so-called "neurogenic sarcoma group." Quick and Cutler (16), Stewart and Copeland (24), and more recently Adair (1), by reviewing the material at Memorial Hospital, were able to still further enlarge the scope of the group, so that, according to the last publication (1) in 1932, there were admitted to Memorial Hospital during the period from 1916 to 1932 a total of not less than 317 patients afflicted with neurogenic sarcoma. On the basis of a review of this material, the present definition of neurogenic sarcoma is that it represents a later, malignant development of neuroma, neurofibroma, fibroma molluscum, and plexiform or cir-

coid neuroma. As such, according to Stewart and Copeland (24), it is but one link, the final link, of a chain leading through varied clinical pathologic entities up to fully developed von Recklinghausen's neurofibromatosis with all its diverse related manifestations. This, then, also indicates that most neurogenic sarcomas are not malignant from the beginning. Just where the borderline lies is exceedingly difficult to estimate, but it may serve to explain to some extent the apparent discrepancies in the statistics dealing with the end-results of the fibroblastic (spindle-cell) sarcoma group as a whole. If doubtful links in the chain are declared malignant, this may increase the percentage of favorable results, whereas if only the undoubtedly sarcomatous forms are included, the final cures may appear less numerous. The clinical picture is characterized by the fact that a small tumor, which not infrequently has been present for a number of years, starts to enlarge very slowly. The patient reports to his physician, who removes the lesion, usually declared as benign, only to find that within a short time there is a recurrence. A second or even third excision is made before the malignant nature is realized and the criteria of sarcoma are recognized histologically. By this time the disease has acquired a great tendency to extend into the surrounding structures, to the regional lymph nodes, or to the lungs. When such a situation has arisen, a differentiation from the true spindle-cell sarcoma may appear exceedingly difficult if not impossible, on the basis of the morphology of the tumor tissue alone. In certain instances, the prompt response to irradiation may be construed as a criterion in favor of true spindle-cell sarcoma.

The degree of radiosensitivity of the fibrosarcoma due to the more adult nature of the tissues of which it is composed, is considerably lower than that of the fibroblastic spindle-cell sarcoma, but somewhat higher than that of the neurosarcoma. Because of this, and since radical excision can be accomplished with ease in the

TABLE III—TABULAR ARRANGEMENT OF CASES OF SARCOMA OF SOFT PARTS
(Harper Hospital 1922-1929 inclusive)

Harper Hospital 1922-1929 Inclusive

No	Case	Sex	Age	Histologic Diagnosis	Origin	Stage	Type of Treatment	Dose	Series	Extent of Treatment	Extent of Metastases	Result	Duration Since Onset (Yrs)		Duration Since Treatment (Yrs)		Remarks
													Since Onset (Yrs)	Well (Yrs)	Dead (Yrs)	Well (Yrs)	
1922																	
1	A S	M	9	Angio	Back	I oc	Bio D\	Ma	3	I cision skull	Later brain lungs	+	0 1	1 3			
2	M S	F	55	Round cell	Neck	d m	Bio D\	Ma	2	Neck	Glands abd last hem	+	0 3	0 5			
3	A C	F	31	Fibro	Hand	I oc	4 Exc D\	Ma	2	Hand		W	2 5				
4	C P	F	52	Mixed cell	Stern res	Loc	Bio D\	Ma	2	Chest	Later lungs mediast.	+	1 0	0 5			12 6
5	F H	M	18	Sm spindle cell	L thigh	r m	Bio D\	Ma	1	I cision in	Inguinal gl	+	2 0	0 6			
6	A B	F	30	Fibro	Hip	I oc	2 1/2 xc D\	Ma	1	Hip	lungs	+	2 0	0 6			
7	S B	F	48	Polymorph cell	Breast	I oc	I oc Exc D\	Ma	1	Breast reg		W	7 0				12 0
8	R C	F	59	I clesbro	Aortic wall	r m	2 Lapar D\	Ma	1	glands	Abdominal glands	W	0 3				12 0
9	R C	M	62	Round cell	Thymus	r m	Bio glands D\	Ma	1	Abdomen	Cervical glands	+	1 0	1 7			
10	A W	M	73	Neurofibro	Neurogenic	r m	Bio D\	Ma	1	Chest neck	von Recklinghausen	+	0 5	0 3			
1923																	
11	J C	F	11	Vase rd cell	Broad lig	d m	Lap Bio D\	Ma	4	Abdomen skull	Lumbar spine skull	+	0 3	1 6			
12	P P	F	73	I ctiomyo-	Des ut fib	d m	Hyster Rec D\	Ma	3	Abdomen all	Rec abd all lymph	+	1 0	0 7			
13	B J	M	62	Sm round cell	Sclera	loc	I nucleation D\	Ma	1	Orbit reg	glands	W	0 3				11 9
14	R R	F	76	Spindle cell	Breast	d m	Rad amp D\	Ma	1	Lymph glands	All lymph glands abdo-	+	2 0	0 1			
15	T W	F	45	Fibro	Back of neck	loc	2 Excisions D\	Ma	1	Neck	men	+	5 0	4 0			
16	N S	F	40	Spindle cell	Maxilla	r m	Bio D\	Ma	1	Face neck	Entire face glands neck	+	0 3				
17	H S	M	40	Spindle cell	Maxilla	d m	2 Excisions D\	Ma	2	Face all	Face all lymph glands	+	3 0	0 2			
18	A W	M	62	Spindle cell	Thigh	d m	Bio D\	Ma	2	Lymph glands	Lungs	+	1 6	0 2			
19	W D	M	74	Spindle cell	Pelvis	d m	Lapar Bio D\	Ma	6	Generalized	Lymph glands lungs	+	2 0	2 2			
20	J K	M	51	Myxo	Bladder	loc	Suprapub Cystot	Ma	4	Pelvis abdo	Later lungs	+	1 0	3 5			
21	R W	M	47	Spindle-cell	Abd wall	loc.	Incomp remov D\	Ma	1	Abdomen		+	0 8				
22	H H	M	76	Fibro-	Abd wall	loc	Ra Excision D\	Ma	1	Abdomen		W	5 0	11 0			
23	A T	F	12	Large rd cell	I umb reg	loc	Bio D\	Ma	3	Lumbar area	Trans myelitis (?)	+	0 5	0 7			
24	T R	F	35	Embryonal cell	Retropetition	loc	Removal D\	Ma	1	Abdomen		W	2 0				
25	H B	F	72	Spindle-cell	Breast	loc	Loc excision D\	Ma	1	Breast reg		+	1 5	1 6			
26	C D	F	78	Rhabdomyo	Kidney	d m	Incompl remov D\	Ma	1	Abdomen chest	Abdomen mediast glands	+	2 0	0 1			

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27	I O	M	60	Embryonal cell	Retropit.	r m	Laparotomy D\	1	Abdomen	Abdominal ascites	+	0 5	0 5	10 6	+ Acute append
28	C f	M	41	Myxo-	Forearm	loc	Excisions 2 D\	Ma	Forearm reg glds	(?)	W	1 0	0 5	10 6	
29	T D	P	29	Fibro-	Sole	loc	Excision D\	Ma	Sole	(?)	+	0 5	5 1		
30	J P	P	53	Polymorphous c	Shoulder	loc	Excision D\	Ma	Shoulder reg glds	(?)	+	2 0	4 0		
31	W P	P	70	Polymorphous c	Axilla	loc	Excision D\	Ma	Axilla neck chest	Regional glds mediast	+	1 0	2 0		
32	N C	P	18	Spindle cell	Breast	d m	D\	Ma	Breast reg glds, mediastinum		+	1 0	0 8		Now pulm TB
33	J U	P	42	Fibro	Scapular reg	loc	Excis rec D\	Ma	Scap reg ax glds		W	7 0		10 6	
34	A M	P	41	Spindle cell	Leg	loc	Excision D\	Ma	Leg groin abdomen		W	1 0		10 6	
35	C S	P	76	Spindle cell	Neck	loc	Excis rec D\	Ma	Neck nll lymph glds		W	0 7		10 3	
36	S f	M	39	Fibro-	Post thor wall	loc	6 Excisions D\	Ma	Thigh pelvis chest	Lungs	W	8 0		10 2	
37	N W	P	67	Fibro-	Dorsum foot	loc	D\ amputation	Ma	Thigh pelvis chest		W	1 0		10 3	
38	G C	M	70	Spindle cell	Thigh	d m	Excision D\	Ma	Abdomen	Later lungs liver	+	0 3	2 0		
39	M W	P	5	Embryonal cell	Kidney	loc	Nephrect D\	Ma	Thigh Incompl	Liver	+	2 0	0 1		
40	P D	P	52	Rhabdomyo-	Thigh	d m	Bio D\	Ma	Finger reg		+	0 6		10 0	
41	P M	M	13	Fibro	Finger	loc	Excision D\	Ma	Pelvis abdom-men	Later abt rec ascites	+	1 0	3 0		
42	C K	P	38	Leiomyo-	Deg ut fibroid	loc	Hysterect D\	Ma	Orbit neck	Later metas lymph glds chest	+	2 0	3 5		
43	M W	P	40	Angio	Sclera	loc	Excision D\	Ma	Abdomen		+	2 0	0 1		
44	R A	P	56	Rhabdomyo-	Kidney	loc	D\ removal	Ma	Nose neck		W	0 6		10 5	
45	A M	M	75	Myxo	Nose	loc	Excis D\ Ra	Ma			+	0 6			

1025

6	15	P	24	Spindle cell	Fascia lumb muscles	loc.	Incompl Bx DX	Ma	2	Abdomen		W	0 5	0 5	(? +)
7	M M	P	33	Round cell	Ovary	loc	Removal DX	Ma	1	Abdomen			0 5	0 5	
8	P T	M	70	Spindle cell	Thigh	loc	Bio, DX	Ma	3	Thigh	Later lungs	+	0 3	1 0	
9	J S	M	53	Spindle cell	Thigh	loc	2 Exc DX	Ma	3	Thigh pelvis	Later lungs	+	0 9	1 3	
0	M M	P	28	Leiomyo-	Deg ut fib	d m	2 Oper DX	Ma	2	Abdomen chest	Lungs		2 0		
1	S P	P	23	Spindle-cell	Eye	loc	2 Exc DX	Ma	2	Orbit		W	2 0		9 0
2	H G	M	7	Spindle cell	Neck	loc	Excis DX	Ma	1	Neck	Later gen metast	+	1 0	4 5	
3	I O	M	78	Angio-	Retropit	loc	Removal DX	Ma	2	Abdomen					
4	N G	P	30	Leiomyo	Deg ut fib	d m	Hysterect DX	Ma	1	pelvis	(?)	+	0 6	1 0	
5	P P	M	56	Cylindrical cell	Parotid	loc	Excision DX	Ma	1	Pelvis chest	Lungs	+	3 0	0 3	
										Parotid		+	4 0	9 0	+ Endocur dtis

Abbreviations: D\ = Deep x ray therapy with 200 kv 1-1.5 mm Cu and 1 mm Al. Ma = massive (dose) indicating 90-100 per cent S U D in one sitting. Pr = fractionated (dose) indicating 30-40 per cent S U D at shorter or longer intervals. loc = localized. r m = regional metastasis. d m = distant metastasis. + = dead. W = well.

TABLE III (continued)

No	Case	Sex	Age	Histologic Diagnosis	Origin	Stage	Type of Treatment	Dose	Series	Extent of Treatment	Extent of Metastases	Result	Duration Since Onset (Yrs)	Duration Since Treatment		Remarks
														Dead (yrs)	Well (yrs)	

1926																
56	J R	M	35	Spindle cell	Sclera	loc	Excision DX	Ma	1	Orbit		+	4 0?	4 5		+ Meningitis
57	J L	M	41	Myxo	Abd wall	d m	2 Excisions DX	Ma	2	Abdomen	Abd inguinal glands	+	5 0	0 6		
58	M T	F	15	Polymorph cell	Thigh	loc	Excision DX	Ma	2	Thigh			0 2			Untr
59	A B	M	20	Angio	Retropert	d m	Expl lap DX			Incomplete treatment	Lungs	+	0 6	0 1		
60	C B	M	70	Spindle cell	Thigh	loc	Bio DX	Ma	1	Thigh		+	2 0	3 5		+ Uremia
61	M P	F	20	Adeno	Breast	loc	Rad amp DX	Ma	2	Breast reg						
62	I S	F	14	Spindle cell	Neck	d m	Bio DX	Fr	2	Neck chest	Lungs	W	2 0	0 3	8 5	
63	F J	F	3	Alveolar cell	Pye	loc	Enucleation DX	Fr	2	Orbit chest		+	0 5			
64	S M	M	30	Myxo	I eg	loc	Removal DX	Ma	1	Leg pelvis		W	0 5	2 0	8 3	

1927																
65	P B	M	8	Round cell	Retropert.	d m	Explor lapar DX	Ma	12	Abdomen	Later lungs brain	+	0 3	3 0		
66	J T	M	22	L spindle cell	Neck	d m	Bio DX	Ma	1	All lymph	I lymph glands		1 0			Untr
67	J S	M	30	Spindle cell	Thigh	d m	Amputation DX	Ma	1	Thigh chest	Mediastinum	+	0 6	0 5	7 5	
68	R D	M	31	Spindle-cell	Glut reg	loc	Excision DX	Ma	1	Pelvis chest		W	0 5			
69	J J	F	57	Felomyo-	Uterus	loc	Hysterect DX	Ma	1	Pelvis			?			Untr
70	S W	M	50	Round cell	Tonsil	r m	Bio DX Ra	Ma	1	Oral cav	Cerv lymph glands		1 0			
71	C R	F	35	Sarcoma	Tonsil	d m	DX	Ma	1	Neck	Lungs		1 3	2 3		Untr
72	I M	M	26	Spindle cell	Appendix	d m	I aparotomy			Incomplete treatment	Miliary peritoneum	+	1 0			
73	C T	F	16	Fibro	Face	loc	Excision DX	Ma	2	Face neck		W	1 0	7 0		(?+)
74	J J	F	21	L round cell	Neck	d m	Bio DX	Ma	5	All lymph	All lymph glands medi					
75	T C	M	45	I round cell	Retropert	d m	Explor lapar DX			Incomplete treatment	Lymph glands liver	+	0 5	1 6		Some lesion present
76	J I	M	51	Alveolar cell	Neck	d m	Bio DX	Ma	3	Neck	Sternum mediastinum	+	1 0	0 1		
77	W P	M	38	Neurofibro	Forehead	loc	Bio DX	Fr	30	Forehead		W	0 4	0 5		

1928

74	C C	M	10	Neurofibro	Thigh	loc	Excision DX	Ma	3	Thigh	W	17 0	0 8
75	J R	M	15	Round cell	Tonsil	loc	Excision DX	Ma	1	lymph glands chest	W	0 5	0 5
76	J C	P	24	Myxo	Abd wall	loc	Excision DX	Ma	2	Pelvis abd	W	2 0	0 4
81	J P	M	50	Myxo	Fluor wall	d m	Bio DX	Incomplete treatment			+	1 0	0 1
82	J S	P	15	Round cell	Arm	d m	Excision DX	Ma	1	Generalized	+	1 5	0 1
83	P K	M	30	Fibro	Finger	r m	2 l xcs DX	Ma	2	Finger res. glands	W	3 0	0 0
84	J S	P	61	Elemyo	Dist ut fib	loc	DX	Ma	5	Abdomen	W	1 0	0 4
85	S S	M	28	Fibro	1 lb tendon sheath	loc	Excision DX	Ma	1	Ankle	W	0 5	0 4

1929

86	J D	M	55	Spindle cell	Face	loc	Bio D\	Ma	5	Arm chest	+	0 4	1 0	
87	C D	P	60	Round cell	Neck	loc	Bio D\	Ma	1	All lymph glands chest abd	+	0 3	1 1	+ Apopl
88	J S	P	48	Spindle cell	Thigh	d m	Bio D\	Ma	7	Thigh chest lymph glands	W	1 0	2 0	5 9
89	J I	P	40	Angio	Cerv ut	loc	Hysterect D\	Ma	2	Pelvis	+	1 0	2 0	5 4
90	P C	M	10	Fibro	Back of neck	loc	Excision D\	Ma	2	Neck	W	0 5		
91	C S	P	72	Fibro	Arm	loc	Excision D\	Ma	2	Arm	+	1 0	0 2	+ Apopl
92	J P	M	43	Spindle cell	Sole	d m	2 l'excisions D\	Ma	2	Sole pelvis	+	0 8	0 4	
93	P R	P	20	Alveolar cell	Forearm	d m	Bio D\	Ma	4	Forearm reg glands	+	1 5		(? +)
94	H P	P	33	Elemyo	Uterus	loc	Hysterect D\	Ma	3	Pelvis abd	W	0 8		5 4
95	M H	P	17	Fibro-	Palm	loc	Excision D\	Ma	1	Palm reg glands	W	2 0		5 4
96	W H	M	18	Mixed cell	Soft palate	loc	Bio Ra D\	Ma	2	Head neck	W	1 0		b 4
97	H K	M	65	Fibromyxo-	Thigh	loc	2 l'excisions D\	Ma	4	Thigh reg glands	W	0 6		5 3
98	C C	M	38	Spindle cell	Leg (l'insc)	d m	4 l'excisions D\	Ma	1	Chest	W	3 0	0 2	
99	J F	P	4	Round cell	Retropit	loc	1 spl lapar D\	Ma	5	Abdomen chest	+	0 3	1 0	
100	A C	P	36	Fibro	Ankle	loc	2 l'exc D\ Ra amp	Ma	3	Ankle chest	W	1 5		5 3
101	P K	P	30	Fibro	Index finger	loc	2 l'excisions D\	Ma	5	Finger	W	7 5		5 1

Abbreviations: DX = Deep x ray therapy with 200 kv 1 1 6 mm Cu and 1 mm Al Ma = massive (dose) indicating 90-100 per cent S U D in one sitting Pr = fractionated (dose) indicating 70-80 per cent S U D at shorter or longer intervals loc = localized r m = regional metastasis d m = distant metastasis + = dead W = well

great majority of instances, surgical intervention must form the method of choice in the fibrosarcoma, irradiation to be carried out post-operatively in a prophylactic manner. In the neurosarcoma, radiation therapy constitutes the predominating procedure. The first entails the administration of larger doses in more massive series, whereas in the latter radiation is divided into small fractions and extended over a long period. In some of our cases of fibrosarcoma, excision was repeated several times (occasionally as often as six times), and each time followed by irradiation with a dose of from 80 to 100 per cent S U D, until finally a permanent control of the lesion was brought about. If a fibrosarcoma is inoperable from the beginning, the radiation therapy is pursued with fractionated doses of from 50 to 60 per cent S U D and at longer intervals, so as to allow a greater tolerance of the normal tissues. A similar technic is followed in neurosarcoma, except for the fact that the fractions of the dose are still smaller (only from 30 to 40 per cent S U D), since roentgen therapy most often extends over several years. Neither in fibrosarcoma nor in neurosarcoma is there an attempt made to extend the irradiation beyond the site of the primary lesion unless definite metastasis has already taken place.

The number of fibrosarcomas treated in our series includes 17, of which 82.4 per cent were apparently cured. In all instances, a combination of surgery and irradiation was used. The surgical interventions in the main consisted of local excisions excepting one case in which amputation was performed. The radiation therapy was carried out with the technic described above. The exceedingly high percentage of cures in this group, as compared to statistics from some other sources, may, in our mind, be attributed to the fact that a very careful pathologic selection of the malignancy index was made, the more undifferentiated forms being included in the spindle-cell sarcoma group.

The series of neurosarcoma comprises only three patients, one of whom is dead,

and the other two alive seven years after incipency of the treatment. In one of these latter, in whom operative removal was impossible, irradiation was carried out regularly for a period of seven years (thirty series), the lesion being now considerably smaller than at the beginning, but still having failed to disappear entirely. It is interesting that in very rare instances malignant tumors of the nerve trunks may appear quite radiosensitive. Stewart (23), for example, reports a ganglionic neuroblastoma, probably arising in the cervical sympathetic ganglion, of a young boy, which proved as sensitive to irradiation as lymphosarcoma. Large pulmonary metastases produced by this tumor "regressed dramatically, recovered and regressed again, until the patient could tolerate no further treatment."

MYXOSARCOMA

The chief sign of malignancy of myxosarcoma lies in the local effect on the surrounding structures. Due to the rather slow rate of growth, this effect develops only in the advanced stages, so that many myxosarcomatous tumors reach comparatively large sizes before they become uncomfortable to their hosts. Metastases to the regional glands or lungs occur usually very late. From the point of view of radiosensitivity, these tumors form a favorable group. They respond well to large doses (from 90 to 100 per cent S U D) of roentgen rays, the regression occurring at a somewhat slower rate than in most other radio-responsive sarcomas, but complete disappearance, following repetition of several series of roentgen therapy, being not infrequent. In our series there are eight cases of myxosarcoma of various origin, four of which (50 per cent) have apparently been cured. In the remaining, metastases developed to the lungs, in one case nearly four years after complete disappearance of the primary tumor.

LIPOSARCOMA, XANTHOSARCOMA

The opportunity has escaped us to treat one single case of liposarcoma but.

according to Stewart (23), "these malignant tumors of fat tissue afford the radiologist a happy relief" They show from moderate to marked radiosensitivity and even when they are made up of adult appearing fat cells, they will respond relatively well to irradiation, yielding to "doses little more than sufficient to cause regression of the more resistant lymphosarcomas" Brunn (2) and Selman (22) likewise reported favorable results in individual cases

One case of xanthosarcoma irradiated by us (in 1930) responded very promptly, a phenomenon which was noted also by Stewart (23) in his cases The exceedingly high radiosensitivity observed in both these types of tumors is very difficult to explain except, perhaps, in the sense that morphologic criteria can be invoked in the least as the responsible factor

LEIOMYOSARCOMA, RHABDOMYOSARCOMA

The pathologic criteria of leiomyosarcoma are ill-defined This fact greatly reflects on the statistical studies reported, some investigators claiming that the condition occurs rather frequently and others considering it as a rarity Unbehau (25) for example, reports 6 per cent (and later 3.4 per cent) of leiomyosarcoma in 356 uterine fibroids Likewise Wintz (26), as already mentioned, reports 12 per cent of leiomyosarcomas in a total of 367 sarcomas of all types, with a final cure of 57 per cent Corscaden and Stout (4), on the other hand on the basis of numerous statistics collected from the literature, arrive at the conclusion that the condition is very rare occurring in from 0.39 to 0.5 per cent of all cases of uterine myoma Krauskopf (11) very recently published an article stating that he was able to record only 31 case histories of undoubted leiomyosarcoma from the entire literature three involved the bladder, some the gastrointestinal tract a very few other organs as kidney, prostate etc and the remainder the uterus The chief difficulty in the histologic diagnosis of myoma and myosarcoma lies in the variation of opinion as to the exact proportion of the embryonal

and adult elements necessary for the classification Furthermore, as Ewing (8) states, benign myomas may vary in structure in different portions and probably at different periods, but these changes constitute only a local and temporary acceleration of growth, without evidence that they will be transformed into malignant sarcomatous degeneration However, this may be, we note that the radiosensitivity is low in all cases of myomas which present or are suspicious of sarcomatous degeneration This phenomenon is so well known to roentgenologists that a degeneration, malignant or otherwise, of a myoma is considered *à priori* as indicative of a surgical procedure, irradiation being reserved only as a post-operative method Even so, the results are most disappointing Except for a few authors, who, no doubt as a result of looser histologic classification, are able to claim better results (57 per cent cure in the case of Wintz (26), treated mostly by surgery and post-operative irradiation), the remainder (Schreiner (21), Regaud and Lacassagne (17), Sage and Miller (20), and others) are unanimous in considering leiomyosarcoma as one of the most unfavorable groups of all malignancies Of eight cases of leiomyosarcoma, seven originating from the uterus and one from the aortic wall, treated in our series with large doses (from 90 to 100 per cent S U D), only one has remained well for a period of five years All cases were treated by a combination of surgery and radiation therapy In a few, moderate palliation, with temporary restraint of the growth of the tumor, was obtained

In rhabdomyosarcoma, the criteria of radiosensitivity are nearly identical with those of the leiomyosarcoma and consequently the radiation results are equally unsatisfactory Of three cases of rhabdomyosarcoma (two of the kidney and one of the thigh) treated by us, none survived one year following irradiation

IDIOPATHIC HEMORRHAGIC SARCOMA OF SKIN (KAPOSI)

As the last group is mentioned the multiple hemorrhagic sarcoma of Kaposi, al-

though this condition occurs quite rarely. The local lesions appear to be moderately radiosensitive, but dissemination cannot be forestalled unless, perhaps, in the very early stages. In one of the cases treated in 1930 by us, there was an apparently satisfactory response in the beginning, but later recurrences and dissemination to more distant regions occurred and the patient died within two years from the beginning of the treatment. In the literature favorable results are reported by Guarini (9) in 30 cases, by MacKee (14) in 7 cases, Rosh (18) in 2 cases, Collins (3) in 1 case, Craver (5) in 1 case, and by others, but most of these cases were observed for a period of less than five years. Kren (12), in a more recent publication, states that, whereas formerly the disease was considered hopeless, there are now cases on record living after thirty years or longer. He adds, however, that every case of Kaposi sarcoma eventually dies of the disease, the question being only whether the patient survives to this end.

CONCLUSIONS

In reviewing the statistical results in relation to the therapeutic method used in this very complex group of sarcoma of the soft parts, it becomes apparent that neither surgery nor radiation therapy has hard and fast rules. As concerns the former, though the general principle may be that every operable sarcoma should be removed at once, there are instances in which primary radiation therapy may appear of greater benefit. Especially is this true of some highly cellular sarcomas of the fibroblastic group, such as round-cell sarcoma of the tonsil or any other location, reticulum-cell sarcoma, large spindle-cell sarcoma, etc., of the myxo-, lipo-, and xanthosarcomas and of the Kaposi sarcoma of the skin. Moreover, when biopsy is taken in all these instances, it appears considerably safer to attempt to remove a metastatic node *in toto* rather than to try to cut into the tumor proper. As concerns radiation therapy, the degree of radiosensitivity forms the basis of procedure. Yet radiosensitivity in the clinical sense may mean "spectacular"

regression in one case and slow progressive tumor shrinkage in another. The criteria dominating such response must be closely scrutinized and classified. It will be found that in the majority of cases they may be harmonized to greater advantage with surgical indications and that, therefore, an association of surgical and radiotherapeutic methods in the treatment of sarcoma of the soft parts must constitute an essential and most desirable requirement. In the same sense, statistics dealing with a combination of the two methods rather than their opposition will prove of the greater clinical value.

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THE ROENTGEN TREATMENT OF CERTAIN TYPES OF ARTHRITIS¹

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 SLER has remarked that, when a score of remedies are used for one disease, it is probable that none of them has much value. To add still another weapon, or rather to remind you of the availability of still another weapon, for the treatment of arthritis would, therefore, seem to be superfluous, however, the simplicity of application of this weapon, its effectiveness in acute cases of a specific type, and its freedom from objectionable sequelæ make its further utilization worth while.

The first report of the use of roentgen therapy in the treatment of arthritis was that of Sokoloff (1), who, in 1897, used it for the relief of pain in articular rheumatism. Stenbeck (2), in 1898, reported the results of treatment of 52 cases, 40 per cent of these cases showed "considerable improvement" and another 40 per cent "at least subjective improvement." About thirty further papers appeared on the subject up to 1930, since which time numerous articles have been published. Its first mention in the American literature was in Wilhams' classic book, published in 1901 (3).

Since there are many different types of arthritis, it is important that we be clear in describing the types amenable to treatment, a fairly simple classification is that of Allison and Ghormley (4).

(A) Etiology known

- 1 Traumatic
- 2 Infectious (pyogenic, tuberculous, gonorrheal, etc.)
- 3 Neuro-arthritis (tabetic, syringomyelic, leprosy)
- 4 Metabolic (gouty)
- 5 Constitutional (hemophiliac) and anaphylactic

(B) Etiology unknown

- 1 Degenerative (hypertrophic)
- 2 Proliferative (atrophic)
- 3 Rheumatic fever

Of these, the only types we will discuss are the infectious and the degenerative. These have been subdivided, for the purpose of analyzing results, into (1) acute infectious (gonorrheal) and (2) acute infectious (unclassified), chronic infectious, chronic degenerative.

RATIONALE OF ROENTGEN THERAPY

The reason for the beneficial effects of x-ray in cases of arthritis is not known. However, the beneficial effect of small doses of x-rays on acute inflammatory and acute painful lesions of a superficial type has been amply demonstrated and is now generally appreciated. X-rays cause destruction of lymphocytes and other radiosensitive cells, thereby liberating proteins which are set free in the tissues, these appear to stimulate localization of the inflammatory process and absorption of the regional exudate. Natural tendency to repair is speeded and hyperemia subsides. Either as a result of the decrease in swelling or from some cause we do not understand, there is also an analgesic effect. Since x-rays were observed to have this beneficial effect on superficial lesions, it was natural to expect similar results from the treatment of deep-seated and intra-articular inflammatory processes, and such were actually observed. This established their use in acute infectious arthritis and especially in acute gonorrheal arthritis.

The reason for the beneficial effects of x-rays on the chronic degenerative type of arthritis is harder to explain. It is reasonable to suppose that when inflammatory peri-articular exudate complicates these chronic cases, its tendency to absorb should be hastened by radiation,

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similarly, the analgesic effect of x-rays should make the patient feel better, at least temporarily. It is certain, however, that atrophy of the cartilage, persistence of marginal osteophytes, and sclerosis of juxta-articular bone will not be influenced in the least by moderate doses of x-rays.

TECHNIC

While the superficial location of some of the lesions (such as in the wrist joint) did not necessitate it, all cases were treated under uniform conditions in the deep therapy department. The aim of treatment was to deliver a small dose of x-rays, approximately 10 per cent of a full dose, to the affected joint or joints, twice a week, for two or three weeks. The dosage in roentgens, measured in air, without back-scatter, was usually 80 r to each field. A few of the cases received double this dose at each sitting (experimentally), and six cases were treated only over some of the involved articulations, the other joints being used as controls. The results of increasing the dosage were, as one might expect, disappointing. The results in the control cases were very instructive and are separately described below.

The actual technical factors employed were as follows: 200 kv p, 30 ma, filter 0.5 mm Cu plus 1.0 mm Al, λ effective 0.16 Å, distance and field variable according to the depth and the size of the affected joint. For example, a wrist would receive a beam of 10 cm diameter at 50 cm TSD, while a hip would receive a beam of 25 cm diameter at 70 cm TSD. Most joints were treated through ventral and dorsal fields, some through mesial and lateral ones. Except in the case of the wrist, hand, and foot, most joints received two fields on each treatment day. In the seven spine cases treated (patients with chronic hypertrophic arthritis), large dorsal fields only were treated, the field being usually 20 by 35 cm, rectangular.

Some of the acute cases were so exquisitely tender that they could not be lifted from the gurney to the treatment bed, these were treated on the gurney, without

attempting to project the beam in a true ventral or lateral direction on the first treatment day. Almost all of the acute cases had such rapid and, indeed, almost theatrical relief of pain, that they could be centered correctly on subsequent days.

TYPES OF CASE TREATED

Since the response of arthritis to the more simple and time-honored remedies varies somewhat with the economic status of the patient, his ability to secure adequate rest, a proper diet, and so forth, we will report in this paper only a group of patients from one general economic level, all 49 cases having been patients in the City and County Hospital in San Francisco.

Most of the cases of acute gonorrheal arthritis on the Stanford and a few on the University of California Urological Service at the San Francisco Hospital, during a period of approximately 18 months, were treated (30 cases). Nine cases of acute infectious, non-gonorrheal arthritis of various types from different services in the hospital were treated. Three cases of chronic infectious, and seven of chronic degenerative arthritis were also treated. Some of the acute infectious, unclassified, cases were thought at first to be gonorrheal, but their subsequent course, absence of positive smear findings, and so forth, caused their reclassification later.

All of the cases classified as gonorrheal had definite clinical findings of that disease, and almost all had positive smears while in the hospital. None of the non-gonorrheal types were due to specifically identified organisms, such as tubercle bacilli, pneumococci, or so forth. However, the diagnoses were made only after careful examination, and had been made clinically by independent physicians.

RESULTS IN CASES OF GONORRHEAL ARTHRITIS

Thirty cases, with a total involvement of 80 joints, were treated. The ages of the patients varied from 20 to 60. The joints involved included all those of the extremi-

ties and, occasionally, articulations such as those of the spine, jaw, sternum, and clavicle. Thirteen cases were so markedly improved as to warrant the word "cured," 15 cases were much improved, and two cases showed no improvement. Of the 80 joints treated, 75 (93.7 per cent) were improved, and five (7.3 per cent) were unimproved. The 75 joints improved may be divided into 30 "cured" and 45 improved. In five cases of multiple joint involvement, one joint was left untreated as a control. In all five cases, the patient continued to complain of pain, and swelling persisted in the untreated joint, while the other (treated) joint or joints cleared up. Three of the cases received later roentgen treatment to the "control" joint, with subsequent complete improvement. One case was treated subsequently but did not improve at all (although the two other joints in this patient had previously responded with perfect results), one case was not treated, and slowly improved spontaneously.

The average number of treatments in the "cured" group was 5.3, in the "improved" group 5.8, and in the unimproved group 4.5. The actual number of treatments to individual joints varied from one to ten, the majority receiving five or six

treatments. Some case reports from the series will serve as illustrations.

Case 6. A. D., male, 27 years of age, S. F. H., No. 135,455, was admitted on Nov. 30, 1933. His left knee and both ankles had been stiff, swollen, and painful for three weeks. His temperature was 102° F. He had contracted gonorrhea two years before, which had never completely cleared up. Smear showed gonococci. Under a clinical diagnosis of acute gonorrheal arthritis, he was treated by bed rest and given two injections of neoarsphenamine. His joints did not improve, and two weeks after entry roentgen therapy was commenced, all three joints receiving 80 r to each of two fields, biweekly for four doses. Swelling was almost completely gone eight days after commencing therapy and the patient was able to walk without pain. Two days later he was discharged as cured. One year later he returned to the hospital on account of a urethral stricture, his joints had remained well.

Case 9. R. G., male, 33 years of age, S. F. H., No. 131,390, was admitted on Sept. 17, 1933. Both knees had been swollen and painful for one week. His temperature was 99.5° F. He had contracted gonorrhea thirteen years previ-

TABLE I—SUMMARY OF RESULTS, ACCORDING TO NUMBER OF CASES TREATED

Type of Arthritis	No of Cases	Cases Free from Symptoms	Cases Improved	Cases Unimproved
Acute Gonorrheal	30	13	15	2
Acute Infectious	9	4	2	3
Chronic Infectious	3	2		1
Chronic Hypertrophic	7	1	4	2
Total	49	20 or 40%	21 or 43%	8 or 17%
Total Percentage Improved 83%				

TABLE II—SUMMARY OF RESULTS, ACCORDING TO NUMBER OF JOINTS TREATED*

Type of Arthritis	No of Joints ²	Joints Free from Symptoms	Joints Improved	Joints Unimproved
Acute Gonorrheal	80	30	45	5
Acute Infectious	13	6	2	5
Chronic Infectious	10	3	6	1
Total	103	39 or 38%	53 or 51%	11 or 10%
Total Percentage of Joints Improved 89%				

* Involvement of a wrist or ankle with or without some joints of the adjoining hand or foot was counted as only one joint.

ously, and had had five recurrences. Smear showed gonococci. Under a clinical diagnosis of acute gonorrheal arthritis, he was treated by bed rest. Seven days after admission, roentgen therapy was begun, 80 r to each of two fields, over each knee, biweekly for four doses. One week after commencing therapy, marked improvement was noted and two weeks later the patient was discharged, completely relieved.

Case 14 C K, male, 32 years of age, S F H, No 121,311, was admitted on Dec 7, 1932. His right knee had been swollen and acutely painful for one week, his right shoulder had been swollen and painful for four weeks. His temperature was 100.5° F. Eleven years previously he had contracted gonorrhea, which had never completely cleared up. Smear showed gonococci. Under a clinical diagnosis of acute gonorrheal arthritis, the patient was treated by bed rest and roentgen therapy, receiving 96 r to one field over each joint, biweekly for four doses. The temperature had dropped to normal two days after commencing treatment, and four days later the knee showed much improvement. One week later the patient was discharged, the following note being entered in his chart by the attending ward physician: "The only treatment given to this patient's affected joints was x-ray with bed rest. The improvement was remarkable. The patient has been ambulatory for two days and feels fine. He is no longer a hospital case and is being discharged to the clinic for further urethral medication." (Note: Three weeks after dismissal this patient developed acute gonorrheal arthritis of both ankles. He was given similar roentgen treatment to these joints, but without being hospitalized. Complete relief of symptoms and signs followed.)

Case 16 E K, male, 29 years of age, S F H, No 124,092, was admitted on Dec 25, 1932. His left wrist, right elbow, and right shoulder had been acutely painful and stiff for three days, his wrist and elbow were very red and hot. His temperature was 99° F. He had contracted gonorrhea

one year ago, with recurrence five months ago. Smear showed gonococci. Under a clinical diagnosis of acute gonorrheal arthritis, the patient was treated by bed rest and roentgen therapy, the latter commencing four days after admission (by which time the patient's temperature had risen to 103° F). The wrist and shoulder were treated but the elbow was left untreated, as a control, by inserting a lead slide above the copper filter when this joint was under the tube. Four days after commencing therapy this note was entered in the chart by the ward physician: "This patient was given x-ray to the left wrist and right shoulder, but the right elbow was left for a control. Believe it or not, the two treated joints have improved both clinically and symptomatically, but the right elbow is getting progressively worse." Two weeks later the wrist and shoulder were apparently cured. However, owing to the severe pain in the left elbow, roentgen therapy had been commenced over that joint four days after the above-mentioned chart-entry. For some unknown reason, the elbow improved only slightly. The temperature had dropped to normal ten days after commencing therapy. The shoulder and wrist received a total of four treatments, 88 r biweekly, the elbow received seven treatments, at a similar rate. After a rest of one month, four more treatments were given to the elbow. But fibrous ankylosis supervened and the patient's elbow had to be given physiotherapeutic and orthopedic care. The wrist and shoulder remained perfectly well.

Some of the cases of acute gonorrheal arthritis had received foreign protein therapy of various kinds before commencing their roentgen therapy, but without benefit. None received pyrotherapy. Only one of the cases is known to have progressed to fibrous ankylosis following failure of therapy (the "control" elbow in Case 16, above mentioned). Two other cases are listed as unimproved, one of these had partial destruction of the joint surfaces before roentgen therapy was started, and the other patient received only two treat-

TABLE III—CASES OF ARTHRITIS TREATED BY X-RAYS

I Gonorrheal

No	Sex Age	Diagnosis	No of Joints Involved	Dosage r in Air	No of Treatments	Result	Remarks
1	M 22	Gc arth, acute, severe, left wrist, three weeks	1	88 r biweekly	8	Symptom free	
2	M 57	Gc arth, acute, elbows and wrists, four weeks	4	80 r biweekly	7	Improved	Left wrist symptom-free
3	M 44	Gc arth, severe both knees, eight weeks	2	88 r biweekly	7	Unimproved	Rt. knee had bony erosive changes
4	M 46	Gc arth, multiple joint involvement esp severe in ankles left knee and right shoulder	4	100 r biweekly	6	Marked improvement	Left knee used as control and finally treated on account of severe pain
5	M 24	Gc arth subacute, feet, ankles and knees	6	80 r biweekly	7	Improved	
6	M 27	Gc, arth, ankles and left knee, acute severe	3	80 r biweekly	4	Marked improvement	Well one year later
7	M 31	Gc. arth left shoulder, acute	1	80 r biweekly	2	Improved	Treatment discontinued by patient
8	M 36	Gc arth, right knee and toe, acute	2	80 r	1	Improved	
9	M 33	Gc. arth, both knees, acute	2	80 r biweekly	4	Symptom-free	
10	M 36	Gc arth, left ankle and knee	2	80 r biweekly	4	Improved	
11	M 38	Gc arth, both knees and ankles, acute	4	80 r biweekly	6	Marked improvement	Developed arth left hip treated and cured
12	M 26	Gc arth., left knee and both ankles	3	100 r biweekly	2	Marked improvement	Five months later acute exacerbation treated with relief
13	M 37	Gc arth left knee acute	1	80 r biweekly	6	Symptom free	Developed arth right hand, hip, ankle, and both shoulders Given 5 doses to these joints with relief of symptoms
14	M 32	Gc. arth, right knee and shoulder	2	96 r biweekly	4	Symptom free	Developed arth ankles Given 4 doses with relief
15	F 40	Gc. arth, right knee, acute	1	100 r biweekly	10	Improved	Had bone involvement
16	M 29	Gc. arth, right shoulder and elbow, left wrist acute	3	88 r biweekly	4	Symptom-free	Elbow used as a control grew worse finally treated but without relief Joints originally treated cured
17	M 24	Gc. arth, left knee	1	80 r biweekly	8	Symptom free	
18	M 60	Gc arth, both ankles and feet, and left wrist	5	88 r biweekly	5	Symptom free	
19	F 36	Gc arth, left knee, acute	1	88 r	7	Improved	After fourth treatment gap of three weeks owing to an influenzal attack
20	M 24	Gc arth right knee, acute	1	80 r biweekly	8	Marked improvement	
21	M 30	Gc. arth, both knees, acute	2	100 r biweekly	8	Improved	Ankles involved later relieved with similar treatment
22	M 35	Gc arth right knee and ankle, acute	2	100 r biweekly	4	Improved	Right wrist and temporomandibular joints involved and treated later, with relief
23	M 48	Gc. arth both ankles and right shoulder, acute	3	80 r biweekly	5	Improved	Left knee later involved and treated with relief

TABLE III—(continued)

No	Sex Age	Diagnosis	No of Joints Involved	Dosage r in air	No of Treatments	Result	Remarks
24	M 22	Gc arth, right knee, acute	1	80 r biweekly	6	Marked improvement	Discharged before treatment finished
25	M 42	Gc arth, right foot and ankle acute	2	80 r biweekly	2	Slight improvement	
26	M 26	Gc. arth, ankles, knees and lumbar spine, sub-acute	5	80 r (spine 120 r)	3	Marked improvement	
27	M 35	Gc arth, right hip, acute	1	120 r biweekly	9	Marked improvement	Only one field each time
28	M 48	Gc arth, left knee, acute	1	88 r biweekly	8	Marked improvement	Right knee later involved and treated with relief
29	M 40	Gc. arth, left ankle and right knee, acute	2	80 r biweekly	6	Marked improvement	Left knee later involved and treated without improvement
30	F 20	Gc arth, left knee, acute	1	80 r biweekly	5	Improved	

II Non-gonorrheal

31	M 32	Acute infectious arth, both knees	2	80 r biweekly	6	Symptom-free	Later developed suppurative arth
32	M ?	Acute infectious arth, ankle	1	80 r biweekly	3	Improved	
33	F 33	Acute infectious arth, knee	1	80 r biweekly	2	Unchanged	
34	F 26	Acute infectious arth, ankle	1	88 r biweekly	6	Symptom free	Improvement not noted for some weeks
35	M 46	Acute infectious arth, knees ankles, and wrists	6	100 r biweekly	6	Marked improvement	
36	F 33	Acute infectious arth, hand	1	100 r biweekly	3	Marked improvement	
37	F 50	Acute infectious arth, hip and knee	2	88 r biweekly	5	Unimproved	Treated at different dates, one recurrence
38	F ?	Acute infectious arth, hand and elbow	2	80 r biweekly	6	Unimproved	
39	F 46	Acute infectious arth, right knee	1	85 r biweekly	7	Slight improvement	
40	M 50	Chronic infectious arth, knees, ankles and hand	5	80 r biweekly	3	Marked improvement	Dramatic pain relief
41	F 22	Chronic infectious arth, right hip	1	80 r biweekly	8	Marked improvement	
42	M 30	Chronic infectious (?) arth elbow	1	100 r biweekly	4	Unimproved	
43	F 56	Chronic hypertrophic arth spine		200 r biweekly	4	Improved	Spine treated in two sections
44	F 56	Chronic hypertrophic arth, spine		150 r biweekly	4	Improved	
45	M 66	Chronic hypertrophic arth, spine		80 r biweekly	5	Marked improvement	
46	I 75	Chronic hypertrophic arth, spine		100 r biweekly	4	No record	Improved
47	M 68	Chronic hypertrophic arth spine		280 r weekly	2	Improved	
48	M 62	Chronic hypertrophic arth spine		200 r biweekly	4	Slight improvement	
49	M 58	Chronic hypertrophic arth shoulder and spine		80 r biweekly	7	Unimproved	

ments In a few other cases, one out of three or four involved joints failed to respond, the majority of these were sub-acute or subchronic lesions From this, we

gained the impression that the optimum time for roentgen therapy was in the really acute stage

DISCUSSION

Gonorrheal arthritis is an extremely "labile" form of arthritis, many remedies being capable of producing rapid and more or less satisfactory results. However, the very number of remedies recommended, pyrotherapy, typhoid vaccine, omnadin, gonargin, and so forth, indicates that none is specific or certain in its action. At the moment, pyrotherapy, in one form or another, appears to be most popular. However, both this and non-specific protein therapy have such unpleasant by-effects, and are so much less easy to control, that we believe roentgen therapy is unquestionably superior.

Besides being contra-indicated in patients with cardiac disturbances, marked arteriosclerosis and nephritis, pyrotherapy appears to be more uncertain in its results than roentgen therapy. Atsatt (5) recommends for the treatment of gonorrheal arthritis that the patient's temperature be held "above 103.5 degrees F for at least two to four hours", Epstein (6), treating cases of syphilis and gonorrhea, used temperatures "between 102.2 and 104.9 degrees F for six hours", Desjardins (7) used temperatures of "106.5 degrees for five to eight hours". And all of these authors recommend from three to six such sessions of hyperpyrexia at relatively short intervals. In addition to these "ordeals by fire," Atsatt uses dilaudid, scopolamin, and other narcotics in connection with the therapy and urges that "the technician appear calm and self-assured" during the procedure.

However, the results of roentgen therapy are not sufficiently uniform to permit a feeling that it is the last word in therapy. As Desjardins remarks "the effect of radiotherapy is chiefly to relieve pain, and this effect appears to be induced indirectly by causing the resolution of inflammatory deposits which have not yet become organized. In some cases relief from pain is rapid in others it is partial and tran-

sient." Åkerlund (2) regards the effect of roentgen therapy in gonorrheal arthritis as "magical" after very few days all symptoms and signs were nearly gone." Westermarck (8) reports that the end-results of roentgen therapy in a group of cases of gonorrheal arthritis of the hip are better than by any other method, he notes more rapid restoration of perfect function, fewer ankyloses, etc.

RESULTS IN CASES OF NON-GONORRHEAL ARTHRITIS

(a) *Acute Infectious (Unclassified) Arthritis*—The number of cases in this and the subsequent groups is too small to permit of generalizations. However, the actual results are worth recording, as is our clinical impression that the method offers possibilities for much benefit if judiciously employed.

Nine cases of acute infectious arthritis, in which a total of 13 individual joints were involved, were treated. Four cases became free from symptoms, two were considerably improved, and three were not improved at all. In the series of cases treated, the joints involved included the ankles, knees, hips, elbows, and wrists. Eight of 13 joints, or 60 per cent, were improved. Absence of the immediate and often spectacular relief which occurs in cases of gonorrheal arthritis was conspicuous.

(b) *Chronic Infectious Arthritis*—Three cases of chronic infectious arthritis, in which a total of ten individual joints were involved, were treated. Two cases became free of symptoms, and one was not improved at all. The joints involved (and treated) were similar to those in the acute infectious group.

(c) *Chronic Hypertrophic (Degenerative) Arthritis*—Seven cases of chronic degenerative arthritis of the spine (spondylitis deformans) were treated. The ages of the patients ranged from 56 to 75. Only one case became free from symptoms, four cases improved, and one case was not improved at all. These cases really represent quite a different and much more difficult

problem than those of the previous groups. However, they are included here to permit comparison of the results obtainable with those observed in the other types treated. Definite osteophytic and posterior articulation changes were demonstrable in the roentgenograms. The one case which showed no improvement at all also had severe hypertrophic changes in the left shoulder joint, this joint did not improve either.

The good results reported in the literature in the treatment of chronic arthritis by x-rays are interesting (9, 10, 11, 12). Rohr (9) treated 40 cases after other methods had failed. About one-half of the cases were chronic infectious lesions and the remainder chronic degenerative. He found that small doses, about 20 per cent S E D, were more effective than large doses, such as 45 per cent S E D. He used large fields, in order to radiate the peri-articular tissues as well as the joints themselves. The pain frequently began to decrease on the day after the first radiation treatment, and, later, such effusions as were present absorbed and the mobility of the joints improved. He noted that "young patients reacted better than older ones."

SUMMARY

Thirty cases of acute infectious (gonorrheal) arthritis were treated with small doses of x-rays delivered to the involved joints twice weekly for two or three weeks. Twenty-eight cases (93 per cent) were much improved and two (7 per cent) were unimproved. Approximately half of the improved cases appeared to be completely cured within a few weeks of the end of treatment, the rest improved gradually but, while free of pain, had some slight stiffness or disability in the involved joints.

Five patients in whom joints were left untreated as controls showed no improvement in the untreated joints.

A small group of cases of non-gonorrheal arthritis was also treated. The results in this group, while gratifying, were neither as spectacular nor as convincing as in the gonorrheal group.

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EFFECT OF IRRADIATION OF THE PITUITARY IN DYSMENORRHEA¹

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WE ARE well acquainted with the ability of large doses of x-rays or gamma rays to kill the ovarian follicles and so bring on the menopause. Follicles and corpora lutea will thereafter be absent from the ductless gland system. Small doses of radiation have also been applied to the pelvis with the hope of influencing the endocrine balance. Empirically undertaken, this has seemed to us and others to be at times of some benefit.

Disliking to subject young women to the menopause (big doses) and equally disliking to subject possible progeny to the danger of injury to the genetic apparatus (moderate doses), we gave up ten years ago such attempts to influence the en-

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docrines by pelvic irradiation. However, with increasing evidence being published as to the control exercised by the pituitary upon the ovary, we desired to try irradiation of the pituitary. We realized that this would be empirical, would have a very uncertain theoretical foundation. We could hardly know for sure in any given case of menstrual dysfunction whether we should choose to lessen or to augment pituitary secretion. We doubted if the x-ray could have a true stimulating effect on secretion anyhow, but thought we might answer the question "Does a given dose of x-ray to the pituitary produce any perceptible effect on (disturbed) hormonal function of the ovary?" We knew we should have to limit ourselves to small doses, that, at least until results could be promised, our patients would not put up with epilation.

ANTERIOR PITUITARY SEX HORMONE IN THE BLOOD

EFFECT OF X-RAY TREATMENT OF THE PITUITARY

56 cases assayed	36 cases hormone not increased	<div> <div>3 given x-ray all uninfluenced in amount of hormones</div> <div>33 not given x-ray (only one given "fake")</div> </div>	no cases of hormone increasing to abnormal level			
	20 cases excess hormone in the blood	<div>10 cases not given x-ray</div> <div>10 cases given x-ray</div>	<div> <div>6 AMENORRHEA all unimproved</div> <div>3 MENOPAUSE 2 improved 1 unimproved</div> <div>1 DYSMENORRHEA improved</div> <div>TOTAL</div> </div>		<div>Excess hormone disappeared</div> <div>Excess hormone persisted</div>	<div>2</div> <div>4</div> <div>1</div> <div>1</div> <div>3</div>

What we would have to measure would be the influence on symptoms. These are listed in the accompanying tables. When patients complained of several symptoms they are tabulated under each.

Most of the groups are presumably heterogeneous as to etiology or mechanism. This is unfortunate. We tried to homogenize the dysmenorrhea group by refusing (for this investigation) those cases which were obviously or probably due to pelvic inflammation, tumors, or gross physical abnormalities. Such "primary" or "idiopathic" cases are, of course, the very ones for whom we most need new therapeutic weapons. So, also, we avoided cases of bleeding possibly due to tumors. The amenorrhea cases were all functional (not due to surgery, radiation, pregnancy, or climacterium), and a few (13 per cent) had a diagnosis of neurasthenia or psychasthenia.

In all, 172 patients were accepted for pituitary irradiation. We had subsequently to throw out a number because they were not successfully followed. We also later decided to include only those of the private patients who were under Dr Pettit's own care. The final number of patients tabulated was 110. We think the reduction was not selective, for we observe that, of the 24 matched cases not followed, 13 were in the group that had received radiation and 11 were of those from whom the x-ray had been screened off.

Of the 110, all were followed two months or longer, 39 less than six months and 19 longer than five years. No late roentgen injuries of any kind could be discovered and the only early injury was transient epilation in the first half-dozen treated, in whom the dose was 30 per cent higher than that given the rest of the cases.

TABLE I

DYSMENORRHEA 56 patients given 61 series of X ray to the pituitary	PAIRED CASES		SUPP SERIES RECEIVING X RAY	TOTAL THAT RECEIVED X RAY
	X ray leaded off	Received X ray		
CASES	15	26	20	46
IMPROVED	¹ 33%*	73%	70%	² 72%**
UNIMPROVED	³ 67%	27%	30%	⁴ 28%

*one case recurred after 3 months **3 cases recurred after 3 mos, 1 after 1½ yrs

Average follow-up for each class 1-26 mos, 2-25 mos, 3-22 mos, 4-27 mos

TABLE II

CASES	DYSMENORRHEA COMPLICATED BY	CONTROLS X ray leaded off		RECEIVED X RAY Total of cases in paired and supplementary series	
		Cases	Per cent improved	Cases	Per cent improved
13	Low metabolic rate B M R 9% minus or lower	5	0	8	75%
13	Infantile pelvic organs	2	0	11	82%

ROENTGEN TECHNIC

Treatments were given at 200 kv, 5 ma, 43 cm distance, $\frac{3}{4}$ mm copper plus 1 mm aluminum, 16 minutes to 8×8 cm area on each temple, yielding 110 roentgens (measured in air) (Our machine is very slow) This was repeated in half dosage (8 minutes) weekly for five more sittings. In order to avoid completely any psychologic influence by patient or doctor, two treatment cones were prepared of identical weight and appearance, one labeled *A*, the other *B*. One of these had a lead sheet inserted between copper and aluminum filters, but none of us knew which one this was. Patients were assigned alternately to *A* and *B* courses. It became necessary later to prepare a similar cone, known to be without the lead sheet, so that certain patients could be accepted for "non-experimental treatment." These form a supplementary series, whom we knew to be getting x-ray at the time of their treatment. After 48 of the *A* and *B* patients had been treated, we looked at the cones with the fluoroscope to find which

one transmitted x-rays. Soon after this the labels were removed, and the cones renumbered 1 and 2. Again none of us knew which was the blank one. Another series of matched cases was treated, totaling 98 cases, 49 with each cone. These cones were saved and after tabulating all the cases, five years after the last had been treated, we again looked with the fluoroscope to see which one transmitted x-rays.

It was explained to all these patients that we were trying the effect of two different filters. They understood that the matter was experimental. They were charged nothing for their treatments.

We observe that all this care was in some degree unnecessary, for the percentage of improvement is not very different among those getting x-ray, and known at the time to be getting it, from what it was among those getting the x-rays and we not knowing whether they were getting them or not. However, it does let us feel sure that differences in results are not attributable to our having discriminated (consciously or unconsciously) in regard

TABLE III

CASES	OTHER SYMPTOMS	CONTROLS X ray leaded off		RECEIVED X RAY Total of cases in paired and supplementary series	
		Cases	Per cent improved	Cases	Per cent improved
18	Total bleeding cases	4	0	14	29 %
11	Menorrhagia	2	0	9	22 %
7	Metrorrhagia	2	0	5	40 %
65	Total irreg, scanty & absent mens	23	39 %	42	43 %
22	Irregularity	10	40 %	12	42 %
12	Scanty menstruation	4	50 %	8	37 %
31	Amenorrhea	9	33 %	22	45 %
22	Menopausal symptoms	7	29 %	15	67 %
17	Frigidity	5	20 %	12	33 %
16	Sterility	6	0	10	10 %

to the other therapy (not x-ray) given these patients

We did note one definite psychological effect—even the clerks noticed it—namely, subjective improvement in most of the patients for the first two weeks, irrespective of which cone was being used

Dr F C Fluhmann assayed the blood of some of these patients for anterior pituitary sex hormone. His findings are summarized in Chart I. The necessary resolution into groups makes the numbers seem rather small, but we think there is definite indication that this hormonal function of the pituitary gland was influenced (diminished) by even these small doses of x-ray. We have set this out first because such objective evidence appeals as being more dependable than the subjective evidence of symptomatology

The only definite symptomatic result came in dysmenorrhea, in which improvement was two to one among those getting x-ray, whereas among those getting no x-ray it was disimprovement two to one

The numbers seem large enough to be statistically significant and we have presented them in Table I

We had basal metabolic readings on 52 patients and found 10 of the dysmenorrhea group with rates lower than 9 per cent minus. Three of these 10 patients received a second series of treatments, totalling 13 cases

There were 22 patients with infantile pelvic organs. Only those complaining of dysmenorrhea seemed to improve under x-ray treatment

Because a low basal metabolic rate and genital hypoplasia might mark out groups with endocrine disturbance, we have separated them from the dysmenorrhea cases in Table I and have shown them in Table II. The results look a little better than for the whole group, but the numbers are so small we cannot be sure of their significance

We were often asked to try our pituitary x-ray treatment for symptoms other than dysmenorrhea. Such cases are presented

TABLE IV

NO X RAY	X RAY	NO X RAY	X RAY	X RAY	SYMPTOMS
* ○	* ○	—	—	—	Dysmenorrhea (irreg, frigid)
* ○	○	—	—	—	Amenorrhea (frigid)
* ○	* +	—	—	—	Dysmenorrhea (Amenorrhea)
* ○	* +	—	—	—	Dysmenorrhea (frigid, sterile)
* ○	+	—	—	—	Dysmenorrhea
—	* ○	* +	—	—	Amenorrhea (irreg)
—	+	* ○	—	—	Dysmenorrhea (frigid, sterile)
—	○	—	* ○	—	Amenorrhea
—	○	—	○	—	Amenorrhea
—	* ○	—	+	—	Menorrhagia
—	* +	—	○	—	Menopausal symptoms
—	* +	—	+	+	Menopausal symptoms

+ indicates that improvement followed the series

○ indicates no improvement

* Asterisk marks treatments given "blind" (without knowing whether X ray was reaching patient or not)

in Table III Of all these, only menopausal symptoms seem to have responded appreciably to x-ray therapy

Fourteen of our patients became pregnant, although only one of these had come complaining of sterility We note that of the matched cases, five became pregnant after receiving x-ray therapy and five became pregnant after receiving no x-ray therapy

Due to relapses or persistence of symptoms, 12 patients received more than one series These occur in the tabulations once for each x-ray series given, and they are set forth in Table IV for closer study We observe that four cases of dysmenorrhea had remained unimproved after a simulated treatment, only to improve later after x-ray was really given

One case of amenorrhea improved after a simulated treatment, whereas it had resisted a real one This example interests us because it illustrates the pitfalls of clinical observation which we designed our "matched case" technic to avoid

CONCLUSIONS

Small doses of x-ray to the pituitary,

385 r (measured in air) directed to each temple, over a period of five weeks, have been followed by amelioration of dysmenorrhea in more than two thirds of a selected group of 56 patients

Special technic of paired controls makes the evidence appear dependable

Menopausal symptoms seem also to have been influenced favorably

In regard to menorrhagia and metrorrhagia, the evidence is inconclusive

Irregular, scanty, and absent menstruation, frigidity and sterility seem not to have been influenced

An abnormal amount of anterior pituitary sex hormone in the blood was apparently reduced by irradiation of the pituitary

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LOCALIZED PLEURAL EFFUSION ACCOMPANYING CONGESTIVE HEART FAILURE

REPORT OF TWO CASES

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GENERALIZED pleural effusion accompanying congestive failure is observed frequently, but localized effusion associated with heart disease has not been emphasized in roentgen literature. Stewart, in 1929, Kiser, in 1929, and Steele, in 1932, have contributed case reports of this condition to heart journals. Freedman listed cardiac failure as a cause of encapsulated pleural effusion.

So far as we can determine, Stewart (1) recorded the first case. The patient, a female, aged 64 years, suffered four attacks of congestive heart failure over a period of fourteen and one-half months. During each attack an effusion localized to the interlobar space occurred, *during one seizure this was the only evidence of cardiac failure*. The effusion gradually disappeared with clinical improvement, but returned with subsequent attacks.

Kiser (2) contributed the second case. The clinical and roentgen findings paralleled those of Stewart's case. The effusion gradually decreased coincident with clinical improvement and had completely disappeared when the patient was dismissed symptom-free.

Steele (3) reported two cases. One had a pleural effusion localized to the interlobar space, and, in addition, bilateral basal congestion and obliteration of the right costophrenic sinus by a small amount of fluid or adhesive pleurisy. The effusion increased as symptoms became more severe, when compensation was restored, they regressed and finally disappeared. Steele's second case had had symptoms of heart trouble for two years. A roentgenogram secured at the time of the patient's first admission to the hospital showed a pleural effusion localized to the right upper lobe. A subsequent attack of congestive failure occurred eight years later and the

effusion returned in the same location. This again disappeared when the patient became symptom-free.

Stewart and Steele have described autopsy findings in cases of localized pleural effusion accompanying heart disease. There is a generalized adhesive pleuritis of the parietal and visceral pleurae which obliterates the entire pleural cavity, with the exception of the small spaces in which the fluid collects. These spaces are lined by relatively normal pleura or fibrous tissue. The adhesions are dense and fibrous, and the pleura is thickened, this thickened pleura may offer resistance to paracentesis. The fluid is a transudate, cultures of which have not revealed the presence of an organism which could be considered as the etiologic agent.

These autopsies have not revealed infectious or inflammatory processes sufficient to explain the pleurisy. Whether or not there has been an antedating inflammation terminating in adhesive pleuritis, or whether the pleuritis is a result of prolonged congestive heart failure, has not been definitely established by the cases reported. The pleuritis and obliteration are probably secondary to heart failure of long standing, and differ from the usual irregular strands of thickened pleura frequently observed in this type of case. The localizing character is determined mechanically by the small sacs formed between two layers of relatively normal pleura persisting in an otherwise obliterated cavity. It is essentially effusion of cardiac failure.

Since this is not a clinical entity, there are no characteristic symptoms, and because of the small amount, the localized effusion may not be detected by physical examination. The symptoms are those of congestive heart failure. It is important



Fig 1



Fig 2

that the roentgenologist recognize the true significance of this type of pleurisy with effusion. It must be differentiated from all lesions of the pleura and lung which cause small isolated areas of increased density in the roentgenogram. Since patients suffering from heart failure and coronary occlusion frequently have fever, leukocytosis, cough, and chest pain, it is particularly necessary that one shall not diagnose these as empyemas. Occasionally they may simulate metastatic nodules, one of our cases with effusion had been considered probably metastatic by the attending physician.

There are certain characteristics which aid in diagnosis. The effusion is usually sharply localized to the interlobar fissure or to one lobe, and has occurred on the right side in all cases reported. The heart is usually enlarged and the chest may show evidence of congestion, edema, fibrosis, and generalized thickening of the pleura. The fluid gradually disappears with recovered compensation, but may recur at the same location with subsequent attacks. Although the following cases have not

been confirmed by autopsies, the clinical course, physical findings, and roentgen evidence establish, in our opinion, a diagnosis of localized pleural effusion of congestive heart failure.

Case 1 Male, aged 60 years, was admitted complaining of weakness, dyspnea, and nocturnal orthopnea of several months' duration. These symptoms had gradually increased in severity. At first, relief was obtained by bed rest alone, but because of the increasing severity of symptoms he was admitted to the hospital. He did not give a history of infectious diseases preceding his heart trouble. There was no history of important familial diseases. Physical examination showed a well-developed and well-nourished male. The eyes, ears, nose, and throat were normal. Venous congestion was present, and visible pulsations were observed in the neck. He was cyanotic and quite short of breath. There was moisture in both pulmonary bases. The heart rate was 110, and gallop rhythm was present. Systolic blood pressure was 178, diastolic pressure, 108. The heart sounds were of poor quality. The

heart was enlarged downward and to the left, and there was slight abdominal distention and engorgement of the liver. There was no edema of the ankles. X-ray showed pleural effusion localized to the interlobar space, and a large heart (Fig 1).

The clinical diagnosis was congestive heart failure. The patient was treated with morphine, small doses of digitalis, and bed rest. He was markedly improved when he was dismissed from the hospital. A follow-up roentgenogram of the chest was not obtained.

Case 2. Male, aged 72 years, had had high blood pressure for several years. Six months before admission to the hospital he had suffered from orthopnea, dyspnea, and weakness. He had noticed moderate edema of the ankles. He had never suffered cardiac pain. An x-ray made in the clinician's office showed a localized pleural

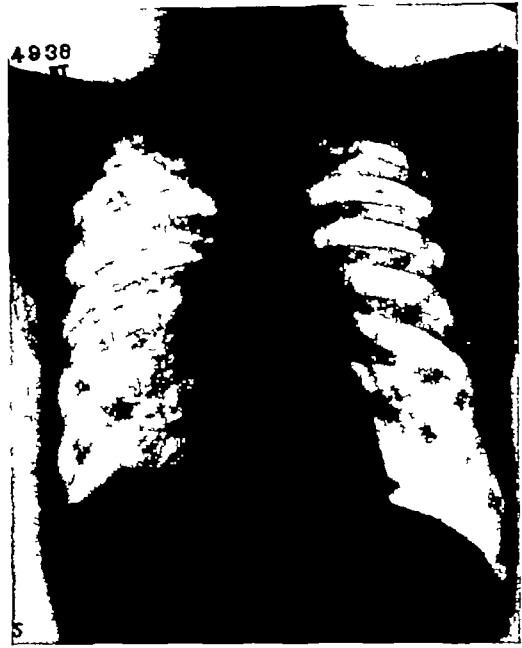


Fig 4



Fig 3

effusion on the right side, and an enlarged heart (Fig 2). He was treated in a private office for these symptoms, and there was gradual improvement. He was admitted to the hospital on Nov 2, 1934, because of urinary symptoms. At this time he

complained of burning, painful and frequent micturition, and was suffering from a paradoxical incontinence. His first urinary symptom had been noted ten years before admission. There was no history of past diseases of importance.

Physical examination showed a well developed and well nourished male. The sensorium was cloudy, and it was necessary to use a restraining sheet to keep him in bed. The eyes, ears, nose, and throat were negative, mouth edentulous, tongue coated, and chest negative. By percussion the heart was not enlarged. No murmurs were detected. Blood pressure, 220/80. There was some swelling of the feet and ankles. The bladder was distended and reached to the umbilicus. The urine was cloudy. The prostate was small, smooth, and hard, but was confined to the capsule. Pulse rate, 88, respiration, 20, temperature, 97.8.

Laboratory examination showed a straw-colored, cloudy urine of alkaline reaction, and a specific gravity of 1.008. A slight trace of albumen, an occasional pus cell, and a rare blood cell were found. The patient received general treatment in preparation for prostatic resection, which was performed on Dec 26, 1934. The post-operative course was good. Although he did not receive digitalis, the dyspnea,

orthopnea, and edema gradually disappeared with bed rest and general urologic treatment. Roentgenograms made during the course of preparation showed a gradual disappearance of the localized effusion paralleling the clinical improvement (Fig 3). He was entirely free of cardiac symptoms on dismissal, and was urinating freely. Chest roentgenograms made at this time showed no evidence of the effusion, and a normal sized heart (Fig 4). It has been reported to us that this patient has suffered recurrent attacks of failure since dismissal, but we have not been able to secure a roentgenogram of the chest during one of these attacks.

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BLOOD CHANGES IN PATIENTS HAVING CARCINOMA OF THE CERVIX OF THE UTERUS IRRADIATED WITH A 300,000-VOLT ROENTGEN APPARATUS¹

REPORT OF NINE CASES

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CHANGES in the blood associated with radiation therapy have attracted considerable attention during the past twenty years. In 1920, Siegel (1), in an extensive article, described the blood changes occurring after radiation. Bosch (2) reported in detail the blood changes which occurred in patients irradiated by the single dose method of Seitz and Wintz. He also reviewed the literature and noted the differences in the observations of investigators. Lack of uniformity as to the part of the body irradiated, and in the factors of treatment, etc., may account for these variations. In 1920, Seitz and Wintz (3) stated that irradiation of the pelvis in cases of carcinoma of the cervix of the uterus sometimes produced permanent blood changes, and in some of these cases may have accelerated death.

Schubert (4) used 500,000 and 600,000 volts in radiating the pelvis for malignant diseases of the female generative organs. He found that the percentage of hemoglobin was usually unchanged, the number of red blood cells was slightly decreased and an absolute leukopenia with a relative lymphopenia was constant in all patients. The white blood cell count fell occasionally as low as 2,000. This marked leukopenia resulted in no harmful consequences.

Lavedan (5) also, studied the blood changes occurring in patients having carcinoma of the cervix of the uterus irradiated with a technic similar to the one employed by us. The only variation was in the voltage, which was 200,000. He noted that the amount of hemoglobin and number of red blood cells remained sta-

tionary or decreased moderately. The white blood cell count always decreased before the third week of treatment, sometimes dropping to 2,250. The decrease was due in greater part to a relative lymphopenia, occasionally as low as 6 per cent. The blood usually became normal within two months after the last treatment. Lavedan called attention to four cases in which a marked relative lymphocytosis, of 40 to 50 per cent, was found several months after the termination of radiation. This was considerably higher than before treatment. All of these patients were well for more than five years. In contrast, two patients with a persistent leukocytosis and an increase of polymorphonuclear cells during irradiation died shortly after conclusion of treatment. The persistent leukocytosis is interpreted as indicating infection. He (Lavedan) refers to Regaud's observation that infected neoplasms react less favorably to radiation.

In the routine blood examinations made during the course of radiation therapy with the 300,000-volt roentgen apparatus at the Morrisania City Hospital, changes were noted which aroused our concern, especially as regards the safety of supplementary radium therapy or additional roentgen therapy in the presence of leukopenia. In the hope that others might be stimulated to investigate this matter, this preliminary report of our observations is presented. Patients with blood dyscrasias were not included in this study. To minimize error, only patients suffering from the same disease (carcinoma of the cervix of the uterus) were studied. However, the anatomic extent of the disease differed in the various cases. The blood was taken several hours after meals, at

¹ Read before the Annual Conference, Division of Cancer, Department of Hospitals, City of New York, April 10, 1935.

the same hour of the morning or afternoon, and always before treatment. The hemoglobin was measured by the Sahli method. Most of the patients received both intra-uterine and vaginal radium, usually after the termination of roentgen irradiation. Lavedan has shown that this form of radium therapy usually has little or no effect on the blood. We have accepted this fact in the interpretation of our data. The pelvis was irradiated through the following portals: one anterior, one sacral, and two gluteal. In four of the earlier cases, lateral pelvic fields were also employed. The portals varied from 10×10 to 15×15 cm, in one case the portal was 20×20 cm. The dosage per field varied from 75 to 150 r. Two or three portals were irradiated, either in one or two daily séances. The 300,000-volt tube, fixed at a distance of 80 cm, is operated at 4 ma, with a filter of 2 mm Cu, plus 1 mm Al, plus wood. The output is about 5 r per minute, measured in air. The dose delivered at a depth of 10 cm is about 48 per cent of the skin dose. The total dose administered about the pelvis varied from 6,300 r to 10,000 r (in air), and the course of treatments extended over periods of from 35 to 75 days.

Case 1 W F, aged 36 years, had advanced carcinoma of the cervix, with infection of the neoplasm.

Roentgen therapy was as follows: 7,500 r in 35 days (30 treatment days) to five fields 10×15 to 15×15 cm, 150–300 r in two daily séances. Vaginal radium (1,900 mgm-hr) was given between the roentgen treatments.

The hemoglobin, which was 60 per cent before irradiation, reached 74 per cent three weeks after the last treatment, with the aid of a 500 cc blood transfusion. The white blood cell count was slightly over 20,000 before treatment, due most probably to the badly infected carcinoma. During the course of treatment, the number of white cells steadily decreased and was still low three weeks after treatment. Unfortunately, this patient left the city

and no further blood examinations could be made.

Case 2 C F, aged 46 years, was bleeding profusely from an ulcerated carcinoma of the cervical stump, but the hemorrhage stopped shortly after external radiation was begun.

Roentgen therapy was as follows: 6,500 r in 38 days (30 treatment days) to five fields 20×20 cm, 140–280 r once daily. Radon gold seeds (1,200 mc-hr) were inserted into a nodule in the posterior vaginal fornix three months after completion of roentgen therapy.

The hemoglobin was 80 per cent on admission and dropped to 60 per cent during treatment. Eighteen months after the last treatment it was almost 90 per cent. The number of white blood cells fluctuated but never descended to a very low figure. Examination made eighteen months after treatment showed a count slightly below that before radiation. The lymphocyte count dropped and rose with that of the total white blood cells, and several times was as low as 10 per cent. The last examination showed the percentage of lymphocytes to be well above the pre-radiation figure. If Lavedan's postulate is true, this patient should have a good prognosis. The blood showed no more evidence of radiation damage in this patient treated once daily, than in Case 1, treated twice daily, all other radiation factors being similar.

Case 3 W F, aged 47 years, was admitted, with marked vaginal bleeding.

Roentgen therapy was as follows: 10,000 r in 15 + 54 days² (51 treatment days) to five fields 12×12 to 15×15 cm, 150–200 r in one and two daily séances. Intra-uterine radium (2,500 mgm-hr) was given immediately following roentgen therapy.

The first hemoglobin was 40 per cent of normal. After two 500 cc blood transfusions, the hemoglobin rose to 73 per cent. The patient then developed a thrombo-

² A total of 69 days—15 days before thrombophlebitis developed and 54 days after recovery from the phlebitis.

phlebitis of the thigh, and radiation therapy was suspended for six weeks. Six months after the last treatment, the hemoglobin was 80 per cent. The number of white blood cells was nearly 11,000 before radiation, dropped to 6,000, and then returned to 10,000, when the phlebitis was noted. Although the white blood cells dropped to 4,000 one month after radiation was started again, examination six months after the last treatment showed them to number 7,000.

Case 4 W F, aged 45 years, was admitted because of profuse hemorrhage from an ulcerated carcinoma of the cervix.

Roentgen therapy was as follows: 7,500 r in 50 days (36 treatment days) to four fields 8×12 to 12×12 cm, 150-200 r in two daily séances. Intra-uterine radium (3,000 mgm-hr) was given between roentgen treatments. Vaginal radium (2,150 mgm-hr) was given immediately following these.

The first hemoglobin measured 48 per cent of normal. With roentgen therapy and one 500 cc blood transfusion, the hemoglobin rose to 60 per cent. Six weeks after the last treatment the hemoglobin was 78 per cent. There were 11,000 white blood cells at the start of treatment, they dropped very rapidly and remained around 3,000 for several weeks, but increased to nearly 7,000 six weeks after the last treatment.

Case 5 W F, aged 36 years, had marked bleeding from the vagina when admitted.

Roentgen therapy was as follows: 7,775 r in 42 days (32 treatment days) to four fields 10×12 to 12×15 cm, 200-300 r once daily. Both intra-uterine (3,000 mgm-hr) and vaginal radium (4,500 mgm-hr) were used immediately following the roentgen therapy.

The hemoglobin measured 55 per cent on admission. Roentgen therapy was given, and with the aid of a 500 cc blood transfusion the hemoglobin very quickly ascended to more than 80 per cent. There were 3,200 white blood cells one week after the first treatment (unfortunately a

count was omitted before radiation was started). Three weeks later the number descended to 1,850. This patient was not radiated for two days and then showed a count of 2,750. The white blood cells increased to more than 6,000 two weeks after the last treatment. The fall and rise in the lymphocytes was parallel to that of the total white blood cells. The hemoglobin and red blood cells showed no evidence of damage even though the patient was treated only once daily.

Case 6 W F, aged 43 years, was bleeding profusely from a very large carcinoma of the cervix, and continued to bleed during most of the period of treatment.

Roentgen therapy was as follows: 6,300 r in 57 days (44 treatment days) to three fields 12×12 cm, 100-200 r in two daily séances. Radium, intra-uterine (2,250 mgm-hr) and vaginal (3,540 mgm-hr), was used immediately at the end of roentgen therapy.

With the aid of three transfusions, given at intervals during the irradiation, the hemoglobin, which at times receded to 42 per cent, reached 88 per cent four months after the last treatment. The number of white blood cells fluctuated considerably but returned to normal one month after the last treatment.

Case 7 W F, aged 40 years, came into the hospital with the history of marked vaginal bleeding.

Roentgen therapy was as follows: 10,050 r in 77 days (63 treatment days) to four fields 10×10 to 12×12 cm, 150-200 r in two daily séances. Intra-uterine (2,900 mgm-hr) and vaginal radium (2,400 mgm-hr) were given immediately upon termination of the roentgen therapy.

The hemoglobin was 60 per cent on admission but dropped to 42 per cent two weeks after the first roentgen treatment. A transfusion of 500 cc blood was given before irradiation, and two transfusions were given during the course of irradiation. The hemoglobin rose rapidly to 80 per cent. Four months after the last treatment it was almost 90 per cent. The number of

white blood cells dropped moderately and was 5,000 four months after the last treatment

Case 8 W F, age 44, had, in addition to carcinoma of cervix, serologic evidence of syphilis and large uterine fibroids

Roentgen therapy was as follows 6,700 r in 35 days (30 treatment days) to five fields 12×12 to 15×15 cm, 200-300 r in two daily séances Intra-uterine radium (2,500 mgm-hr) was used in this patient immediately at the end of roentgen therapy

The per cent hemoglobin (70 per cent) remained stationary during irradiation but receded somewhat three weeks after its termination The number of white blood cells (6,200) decreased sharply soon after treatment was started, and fluctuated during the remainder of therapy, three weeks after treatment it was 4,500

Case 9 W F, aged 38 years, had developed carcinoma of the cervix during the later months of pregnancy Dr Aranow, gynecologist of the hospital, coagulated the cervical neoplasm with endothermy and then performed a Porro cesarean operation in the eighth month of gravidity

Roentgen therapy 6,170 r in 59 days (42 treatment days) to three fields 12×15 to 15×15 cm, 150 r once daily No radium was given to this patient

The white blood cells showed little change The hemoglobin rose steadily, and with the aid of a 500 c c blood transfusion reached 100 per cent six months after the last treatment

In this case, we see the effect on the blood of irradiation where no evidence of carcinoma could be found The effect of carcinoma itself on the blood is difficult to estimate Renaud (6), among others, believes that when blood changes occur in untreated carcinoma patients, a complication such as infection is usually present

SUMMARY

(1) Patients with carcinoma of the cervix of the uterus, treated with a 300,000-

volt roentgen apparatus with the technic and dosage described above, show no evidence of permanent blood damage

(2) The percentage of hemoglobin and number of red blood cells may fall somewhat during a course of irradiation but usually returns to or even exceeds the level observed before irradiation Patients with a quantity of hemoglobin as low as 40 to 50 per cent of the normal, due to loss of blood from an ulcerated lesion of the cervix, begin to show an increase in hemoglobin within a few weeks after the beginning of irradiation, with the aid of one or more transfusions

(3) The total number of white blood cells drops in most cases as early as the second week after the beginning of treatment, thereafter, the trend is irregular The lowest limits reached are far below those expected in untreated cases in one patient the number was as low as 1,850 At no time was it necessary to suspend the treatment because of leukopenia Within a few weeks after the last treatment the white blood cells increase, but usually not quite to the number before irradiation

(4) The drop in the number of white blood cells is due to a decrease of all the cellular elements In three cases in which the data were available, a lymphopenia, both relative and absolute, was present The number of lymphocytes always increases after the cessation of treatment

(5) The number of cases is too small and the time which has elapsed since irradiation is too short to show whether there is any prognostic value in the observed blood changes

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PATHOLOGICAL RARITIES IN CANCER¹

TWO UNUSUAL CASES

By ANGELO M. SALA, M.D., Pathologist, New York City Cancer Institute

AS OUR contribution to this symposium, we wish to put on record two unusual cases which have recently come to autopsy. In both instances, only the postmortem examination supplied the correct diagnosis.

GELATINOUS CARCINOMA OF THE DUODENUM

Case 1. The patient, K. U., a colored female, 59 years of age, was sent to us from another hospital on Jan. 21, 1935, with a clinical diagnosis of carcinoma of the stomach with liver metastases. In August, 1934, she had begun to experience cramp-like pains following meals, attended by nausea, a feeling of fullness, belching, and occasional vomiting of undigested food. Symptomatic treatment relieved her until October, 1934, at which time all her symptoms returned with an additional feeling of substernal pressure after eating. She complained of all these things on admission to our hospital, as well as a loss of 50 pounds in the previous five months. She had never vomited "coffee-ground" material. There was no jaundice, nor did she have unnatural stools.

On physical examination, the liver was felt an inch below the navel, apparently not nodular. No other masses were made out. Roentgen-ray studies of the gastrointestinal tract showed, in the main, dilatation and stasis of the duodenal cap, and stasis and deformity of the descending duodenum. The conclusion was as follows: "Extra-gastric pressure, with deformity of the pylorus and descending duodenum, probably due to a pancreatic tumor." Laboratory examinations, including blood Wassermann and Kahn tests, were negative.

Operation was decided upon and done on Feb. 4, 1935.

Operative Procedure (Dr. Braham Golden) — "A right paraumbilical incision was made about six inches long. On opening the abdomen, a large elevation presented itself in the middle of the wound, the summit of which consisted of omentum and small gut, apparently the third portion of the duodenum. The elevation on exploration proved to be caused by a huge mid-line hard nodular mass, apparently retroperitoneal and pushing forward most of the adjacent structures. The second portion of the duodenum was found somewhat dilated, evidently by reason of outside pressure. The stomach was small and pushed upward under the liver by the mass. Digital exploration of the tumor through the foramen of Winslow showed huge encapsulated nodular masses, probably lymph nodes, in the lesser omentum behind the stomach. A small nodule, apparently a lymph node of neoplastic consistency, was removed."

The surgeon's post-operative diagnosis was retroperitoneal lymphosarcoma. Unfortunately we could neither prove nor disprove this impression, because the small lymph node removed at operation proved to be the seat of only a moderate hyperplasia. Death occurred on Feb. 9, 1935, and an autopsy was done about four hours after death.

Autopsy Findings (Dr. Sala and Dr. Elma Barany) — The hilus nodes were all found markedly enlarged, dull gray in color, firm in consistency, with softening and commencing necrosis at the center. The lungs were generally edematous. The operative incision was clean, the peritoneum was glistening, there was no fluid. The stomach was markedly dilated. The fundus of the gall bladder was adherent to the duodenum and hepatic flexure of the colon. There was felt a huge retroperitoneal mass in the region of the pancreas,

¹ Read before the Annual Conference, Division of Cancer, Department of Hospitals, City of New York, April 10, 1935.

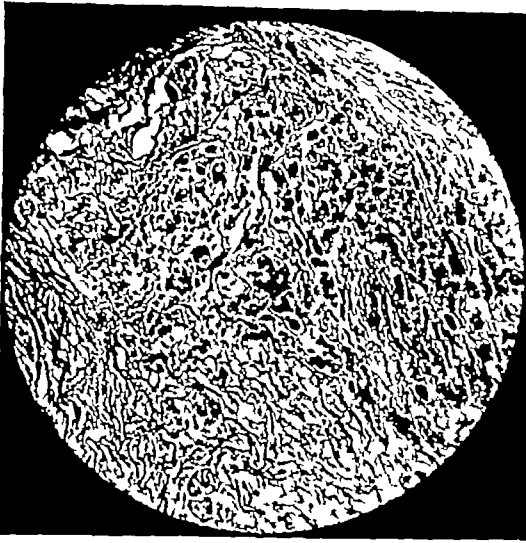


Fig 1



Fig 2

which pushes forward the stomach and gut. The liver was removed, it weighed 1,965 gms, and was moderately congested, but otherwise negative. The bile ducts were natural. Examination now disclosed a huge enlargement of the retroperitoneal nodes, which, in the region of the pancreas, by close contact without matting together, had formed a mass the size of a large orange. This mass of nodes was very adherent to the stomach and duodenum, and was removed with them, along with part of the jejunum. Careful inspection disclosed no lesion in the stomach or supra-ampullary and ampullary portions of the duodenum. The infra-ampullary duodenum, however, was found to be the seat of a large ulcer 5 cm. in diameter, with hard rolled edges, inextricably adherent to, and resting upon, the head of the pancreas and the mass of nodes. The remainder of the intestinal tract was removed and opened; no lesion was found anywhere. The mesentery was negative. The retroperitoneal nodes along the aorta, over the sacrum, and in the pelvis were all markedly enlarged, discrete, and on cross-section appeared like the hilus nodes already noted. The pancreas itself appeared negative on careful examination. Other findings were negative.

The anatomical diagnosis was lymphosarcoma, and the duodenal ulceration was considered to have resulted from pressure. We were greatly surprised by the microscopic examination, which showed a gelatinous adenocarcinoma (Fig 1), with metastases to the lymph nodes mentioned. In view of the autopsy findings, and the thorough examination of the whole gastrointestinal tract, it must be concluded that we have here a case of gelatinous carcinoma of the infra-ampullary duodenum, with extensive lymph node metastases.

The lesion is uncommon enough to justify putting all observed cases on record. For those interested in the literature of the subject, we append reference to two articles, both of which refer in turn to other papers. We feel that in this case there is no way of proving or disproving whether or not a duodenal ulcer preceded the carcinoma. We ourselves have yet to be convinced that gastric or duodenal carcinoma ever arises from an ulcer.

A CASE OF EXTENSIVE HEMANGIOMA OF THE LIVER

Case 2 The patient, J. G., a colored male, 59 years of age, was sent to us from another hospital with a diagnosis of sarcoma of the liver. Shortly before 1932, he

had begun to have vague complaints of indigestion, with constipation. In 1932, he had noticed a gradual enlargement of the abdomen. That same year a laparotomy had been performed at a third hospital, and his family was told that he had an inoperable tumor of the liver. At this operation no liver tissue was excised for microscopic examination. He came to us on Jan 22, 1935, in a markedly poor condition, complaining chiefly of indigestion, nausea, vomiting, and marked constipation. On physical examination there was felt a huge mass occupying three-fourths of the abdominal cavity, apparently arising from the liver and of a doughy consistency, being cystic in places. The lower edge of the mass was felt about one inch above Poupart's ligament. There was no clinical jaundice. Icteric index was 20. Serological tests for syphilis were negative. He was put on custodial care with purely symptomatic treatment. The course was progressively downhill and the patient died on Feb 6, 1935. Autopsy was done a few hours after death.

Only the appearance of the liver will be detailed here. The other findings were unimportant beyond an extensive lobular pneumoma, with pulmonary edema as the immediate cause of death. The huge mass palpated clinically proved to be the liver,

which weighed 6,570 grams. It occupied the right half of the abdomen down to the pelvis, on the left side it extended over to the left hypochondrium. Surface inspection of the liver gave about the same appearance as that of a polycystic kidney. The cut surface showed wellnigh complete transformation of the liver substance into a mosaic arrangement of large blood-filled spaces and areas of hemorrhage, separated from one another by thin fibrous septa. Only scattered small islands of liver tissue could be detected in the right lobe, more liver tissue was present in the left lobe, but here also the predominating picture was that of blood-filled spaces and areas of hemorrhage. Gall bladder and bile ducts were negative.

The histologic picture of numerous areas of the liver was uniformly that of hemangioma. Histologic evidences of malignancy were everywhere lacking (Fig 2). Several retroperitoneal and pelvic lymph nodes, found enlarged at autopsy, all proved on microscopic examination to be the seat of inflammatory and not neoplastic changes.

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XANTHOMATOSIS¹

A CASE OF SCHULLER-CHRISTIAN'S DISEASE TREATED BY IRRADIATION

By HYMAN I TEPERSON, M D, *Brooklyn, N Y*

Radiation Therapist, Beth El and Brooklyn Women's Hospitals, and Associate Radiation Therapist, Brooklyn Cancer Institute, Dr Ira I Kaplan, Director

HERE is a group of diseases characterized by a primary constitutional disturbance of lipid metabolism which leads to an overflow of lipid substances in the blood and tissues. In an effort to rid the blood of excess lipoids, certain cells of the reticulo-endothelial and histiocytic systems ingest and store these fats, with the result that storage-cell tumors are formed in the various bones and organs of the body.

The presence of these tumors in bone causes a local osteoporosis, due to direct pressure of the tumor on the trabeculae. In soft tissues and organs, the lipoids infiltrate the parenchyma and interfere with the function of those organs. In addition, the presence of free lipoids in the tissues evokes an inflammatory cellular reaction as well as a secondary proliferation in the tissues, resulting in a fibrosis or a reaction similar to that produced by any foreign substance.

These three phenomena blend and constitute the typical lipid granuloma or storage-cell tumor, the elements of which are varied only by the rapidity and location of the process.

These storage-cell tumors are sulphur yellow in color, fatty on section, and have a consistency of putty or soft rubber. Microscopically, they are composed of collections of large vacuolated cells each 20-80 μ in diameter, and are often referred to as foam cells because of their resemblance to that bubbling substance. These vacuoles are due to the presence of fat droplets in the protoplasm, which in the process of laboratory preparation are dissolved out, leaving small vacant spaces. The cells simply act as small storehouses, they do not undergo division. When one cell is fully filled with

fat, another joins the group and thus little tumors are gradually formed.

The clinical picture is also variable and depends upon the type of lipid at fault, the acuteness of the process, and the location of the lipogranulomas.

On this basis five clinical entities are recognized:

- (1) Gaucher's disease
- (2) Niemann-Pick's disease
- (3) Schuller-Christian's disease
- (4) Skin types associated with or without diabetes, icterus, and pregnancy
- (5) Essential xanthomatosis

The basic lesion in all of these conditions is the lipid granuloma, but the type of lipid at fault and its distribution is what determines the clinical course. Rowland has coined the name "xanthomatosis" for this group of fundamentally related conditions.

The first three groups affect the skeletal system to a greater or lesser degree, and are, therefore, of special concern to us in this review.

Groups 4 and 5 do not affect the skeletal system, and comprise xanthomatous deposits occurring in the skin, tendon sheaths, aponeuroses, or joint capsules. These conditions are benign and may be associated with icterus, diabetes, or pregnancy. Occasionally, neoplasms or inflammatory processes undergo xanthomatous degeneration.

(1) *Gaucher's Disease*—Gaucher, in 1882, described a condition subsequently identified with his name in a thesis entitled "Épithéliome primitif de la rate, hypertrophie idiopathique de la rate, sans leucémie."

Kerasin, a phosphorus-free cerebroside, is the lipid at fault. This disease may occur at any age (the oldest case reported

¹ Read before the Annual Conference, Division of Cancer, Department of Hospitals, City of New York, April 10, 1935.

was 56 years of age), but usually in female children, and occasionally in sisters. The spleen shows a gradual enlargement, followed by an enlargement of the liver. Pain is usually present in the upper left abdomen due to a perisplenitis. The left kidney gives evidence of dysfunction due to pressure from the spleen. The skin on the exposed parts (face and hands) becomes bronzed.

The blood shows an anemia of a chlorotic type. A moderate leukopenia and, later in the disease, a thrombopenia are present and result in epistaxis and metrorrhagia. Pain in the ribs and long bones is an evidence of bone marrow involvement. The patient may show a considerable emaciation, but the abdomen still remains large, due to the increase in size of the spleen and liver. The superficial glands are rarely involved.

The disease runs a chronic and benign course in adults, but is more acute in children. Death usually results from some intercurrent infection.

Pathologic findings show that typical foam-cell granulomas are present in the spleen and bone marrow. The Gaucher cell is 20–80 μ in diameter. Polymorphous single or multiple nuclei are placed near the cell border. Under high magnification, the cytoplasm appears wrinkled rather than foamy, showing an irregular network like spider web. It stains light blue with Mallory's stain, with acid-fuchsin, anilin-blue-orange G, with previous fixation with picric acid and ammonium bichromate.

In the bone marrow the cells are elongated, spindle-shaped, reveal sharp striations, and occur in bundles. The liver is cirrhotic, but without hypertrophy of the bile ducts. The internal lymph glands are hypertrophied.

Bone involvement is less frequent, but an osseous form has been described by Pick. In the latter, the participation of the organs may be altered so that it predominantly involves the bones. In the flat bones, the spongiosa is filled with a yellow or gray tissue which occurs in diffuse or speckled form. In the long bones, nod-

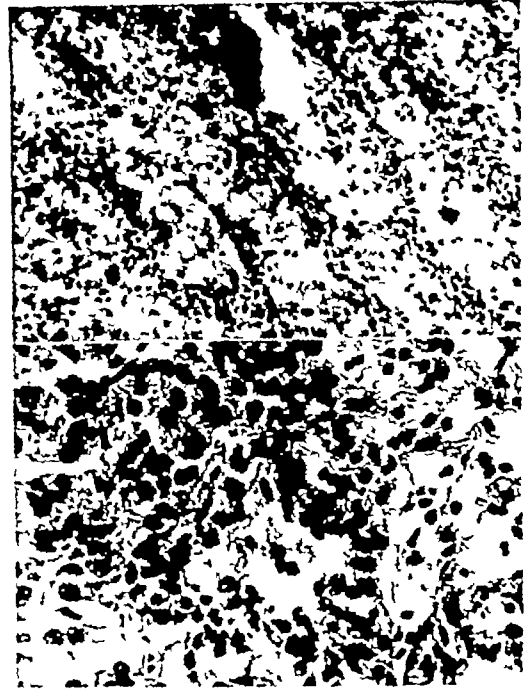


Fig 1 Foam cells in a case of Schüller-Christian's disease (after Rowland). A (upper) Low power. B (lower) High power.

ules form which may fill the marrow cavity.

On roentgen study, the bones appear less opaque and are coarse-grained and worm-eaten. The cancellous bone may show large defects and thinning of the cortex without osteoplastic changes.

The cause of the lipoidosis is unknown. There are other diseases in which an excess amount of fat is present in the blood stream, e.g., diabetes, yet there is no tendency on the part of the fixed tissue cells to ingest and store this fat. This seems to indicate that there must exist a constitutional predisposition on the part of the reticulo-endothelial cells in the individuals affected, to take up this fat. Furthermore, the preponderance of such cases amongst individuals of the Jewish race and often in members of the same family fortifies the opinion of a constitutional disturbance. Whether this disturbance is purely metabolic or associated with a disturbed excretory mechanism, is still to be determined.

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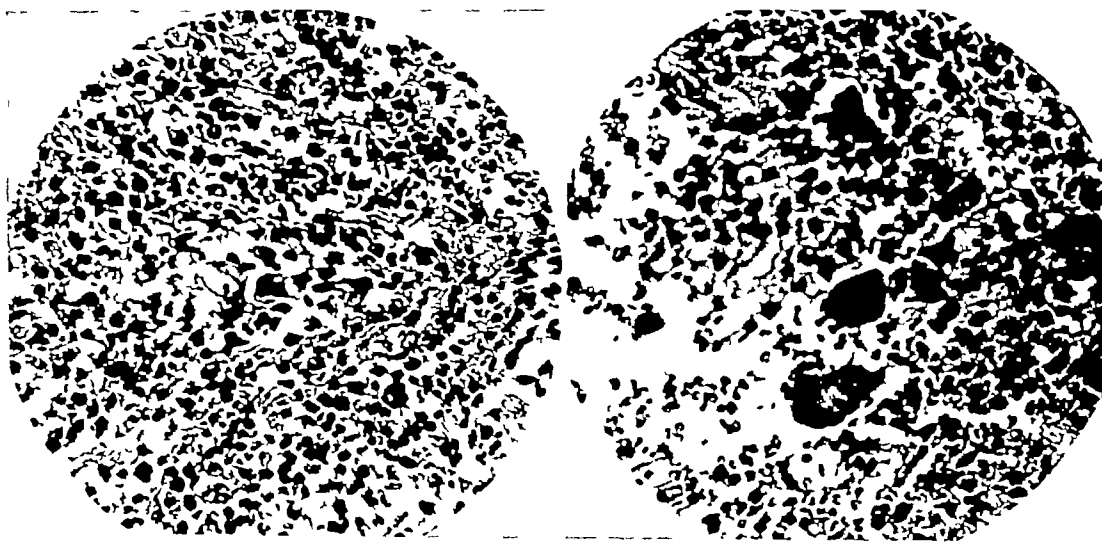


Fig 3 Section of biopsy taken from the lump on the forehead four months after onset of symptoms and before any irradiation was given. The tissue is very cellular, contains many giant cells, some fibroblasts, and resembles osteitis fibrosis.

Fig 4 Same as Figure 3 high power.

and spleen are enormously enlarged and actually determine the size of the abdomen. The lymph nodes are enlarged. The skin is yellowish, due to the intense lipemia, but foam cells are never found in the circulation. Occasional leukocytosis or leukopenia is present.

The diagnosis is usually established by splenic puncture, which demonstrates the presence of foam cells. These are usually smaller than the Gaucher cell.

Pathologic examination shows all organs and tissues saturated with lipoids, they are yellowish in appearance, and indurated, due to the presence of replacement fibrosis.

(3) *Schüller-Christian Disease*—In 1893, Alfred Hand described a case of polyuria associated with tuberculosis in a child, aged three years and six months. Exophthalmos was present and large defects in the cranial bones filled with a sulphur yellow material were found on postmortem examination. He attributed these findings to tuberculosis. In 1921, after reading the reports of Schuller and Christian, he recalled that the case he described in 1893 possessed the syndromic triad of what we now know as Schuller-Christian's disease.

In 1915, Schuller, of Vienna, described two cases, one in a boy of 16 and another in a girl of four years and six months, each of whom showed exophthalmos, diabetes insipidus, and defects in the cranial bones. In addition, the presence of infantile genitals, and panniculus adiposus in the older child led him to assume that the disease was due to a disturbance in the function of the hypophysis.

In 1919, Christian reported another case possessing the same cardinal symptoms in a girl five years old, and inferred from observation of the case over a period of six months that the condition was probably due to a metabolic disturbance. He was able to influence the polyuria by hypodermic administration of pituitary.

In 1928, Rowland's monumental work on the subject gave us the first lucid explanation of the pathologic processes involved and their causal relations to the symptoms, the etiology, however, still remains obscure. It is now agreed that Schuller-Christian's disease is a constitutional disorder of metabolism, with a deposition of cholesterol and its esters leading to a characteristic hyperplastic reaction in the reticulo-endothelial or histiocytic apparatus.



Fig 2 Circumscribed area of rarefaction, involving the frontal bone and roof of the right orbit. The lump present at this site was removed a few days later and sectioned for microscopic study (October, 1932)

ulo-endothelial system. These cells are present in the spleen, liver, bone marrow, and lymph glands. In the spleen, the cells are derived from the reticulum of the pulp, malpighian corpuscles, and adventitia of the arterioles. In the liver, they are derived from the cells of Kupffer and the clasmotocytes of Glisson's capsule. The reticulum cells of the lymph nodes and bone marrow are the other sources.

(2) *Niemann-Pick's Disease*—This condition was originally recognized in 1914, by Niemann, who reported an unknown disease picture in a 17-month-old child. It occurs primarily in Jewish infants and proves rapidly fatal. The phosphatid lecithin, a lipid normally occurring in the body in cellular walls and in nervous tissue mainly, becomes stored in abnormal amounts in the liver, spleen, and other organs. The bone marrow is but slightly

infiltrated, although a skeletal form has been described. The symptoms are similar to those in Gaucher's disease, but are more intense, due to the rapid course of the disease and the wide distribution of the lipoids. The reticulo-endothelial cells are rapidly saturated with the lipoids, following which other tissue cells are forced to store the fats. This results in an overwhelming infiltration with lipoids of practically every organ and tissue of the body. A secondary reaction, similar to a foreign body reaction and fibrosis, occurs in the various organs, and mechanically interferes with the vital functions of those organs. This failure and cachexia eventually result in death before two years.

The marked dyspnea and cyanosis present in these cases are due to interference with respiratory function by secondary fibrosis in the lung parenchyma. The liver

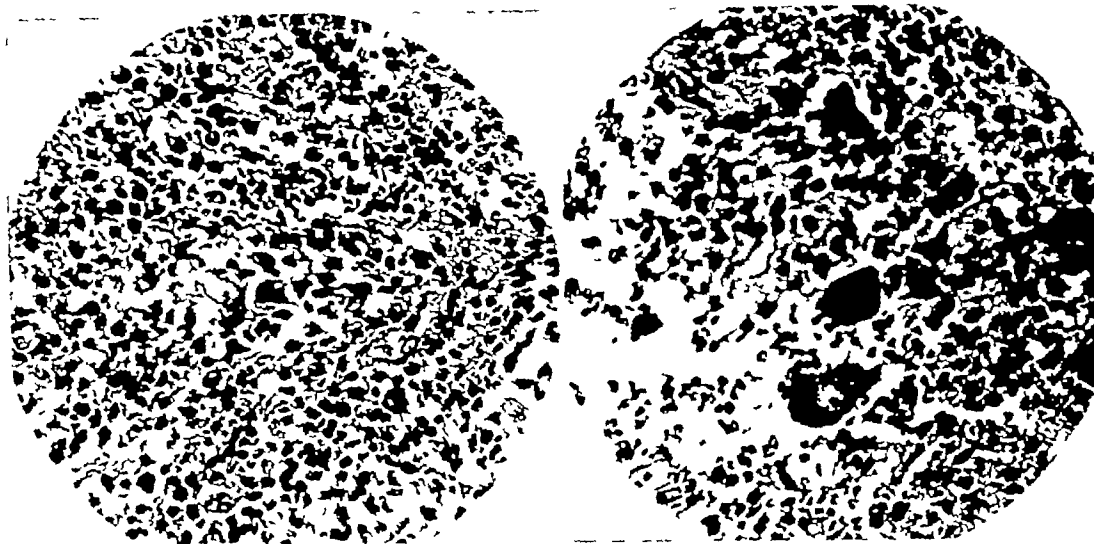


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Fig 5 C. E. now 3 years and six months old. Note exophthalmos and depression of the right eye (August 1934). The prominence of the right forehead is due to the presence of a storage-cell tumor.

In this disease there is a marked involvement of the skull bones and occasionally of other bones, and it may, therefore, be considered as the osseous form of xanthomatosis.

Children are most often affected but the disease may appear during adolescent or adult periods. It is more common in males. The symptoms and pathology vary with different stages of development and with the age period of the patient. The childhood form is most frequent. There is usually a history of good health up to the time of onset. The common childhood diseases may have been present, with prolonged convalescence.

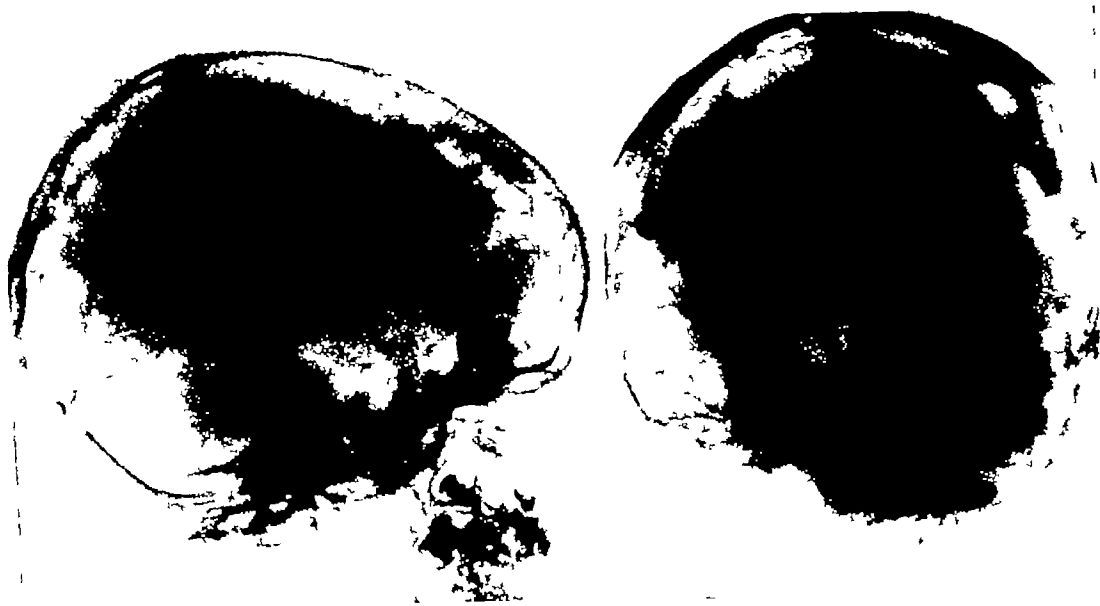
The appearance of a lump on the head, with the demonstration of cranial defects by roentgen examination, is usually the first and most constant symptom. Exophthalmos and diabetes insipidus are usually present and together with the cranial defects constitute the syndrome. In the early stages of the disease, a number of lesser symptoms such as gingivitis, loose teeth, and vague pain may be present. Dwarfism, cessation of growth, failure to gain weight, mental retardation, and adiposogenitalis dystrophy are secondary to glandular lipoidosis and are less frequently

present. As the symptoms are directly related to the pathologic infiltration of the involved organs with lipoids, the appearance of referable symptoms will depend on such involvement if and when it should occur.

There is no regular sequence for the appearance of the symptoms and many need not be present. In the case herewith reported, the symptoms of diabetes insipidus are still lacking, although almost three years have elapsed since the onset. Nevertheless, the symptoms may be progressive and the child become dyspneic and cyanotic. In fatal terminations, death usually occurs in from two to four years as a result of dyspnea, cardiac failure, and anemia. In the adolescent form the condition is more protracted, the symptoms are fewer at first, growth retardation is more prominent, and the bone defects progress at a slower pace. Periods of remission are present. Life may last from five to twenty-five years. The adult type is rare and protracted. The symptoms are those of a true polyglandular syndrome. Arrest of development and mental retardation are pronounced. The bone defects resemble osteitis deformans.

As revealed by Rowland, the pathologic processes have a definite relation to the symptoms. A mass of foam cells or histiocytes loaded with fat appear in the tissues surrounding small blood vessels. These masses gradually become larger, forming granuloma-like nodules, arising from dense connective tissue. The process may be more diffuse and involve many tissues and organs, or a marked fibrosis or a foreign body giant-cell reaction may take place. These changes blend and intermingle.

In bone, the lesions may be circumscribed or diffuse. An eosinophilic infiltration with hemorrhage and necrosis may be present. The bone trabeculae atrophy, due to pressure from the growth of foam cells. Repair and replacement occur by new-formed spongiosa, with occasional osteoid or cartilaginous tissue. If the periosteum is not affected, new bone may develop therefrom. The bone is demineralized and cuts like cheese. Histologically, the bone



Figs 6 A and 6 B Patient C E, roentgenograms of the skull taken 22 months later than that shown in Figure 2. Note the extensive and irregular areas of rarefaction involving mainly the frontal, parietal, and temporal bones. Smaller defects may be seen in occipital region. An island of uninvolved bone is present in the right frontal area. The right sphenoidal fissure is obliterated, indicating involvement of the right sphenoidal wings.

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Changes in the skull are of first importance. If two layers are involved, they are moth-eaten in appearance, but in the large defects involving three layers they are geographic in appearance. Any other bone in the body may be involved. If attempt at repair is present, the edges become blurred. In the adult type, the bone may even become thickened. These bone defects are due to a lipoidosis and not to any endocrine disturbance.

The exophthalmos is due to deposits in the orbit resulting in the formation of a fat pad behind the eyeball. Diabetes insipidus is due to a lipoidosis in the hypophysis. The sella turcica is involved in about one-third of the cases. If the disease involves a vertebra a compression fracture may occur, resulting in a kyphosis or gibbus. The intervertebral discs are never involved. The other glands, such as thymus, thyroid, pancreas, suprarenal, etc., if involved, will give a symptom-complex such as is usually produced by a functional disturbance of the gland. The blood picture shows an in-

creased cholesterol content and may appear cloudy in acute cases.

Treatment—Spontaneous remissions have been known to occur in several cases. Cignolini, in 1928, reported the successful utilization of roentgen therapy in Schuller-Christian's disease in a girl 14 years of age. The cranial defects disappeared completely. Sosman subsequently reported several other cases which he also successfully treated with roentgen rays. Some of these defects, however, are apt to recur. In the case herewith reported, roentgen rays were used with gratifying results. In cases in which the sella turcica is involved, the administration of roentgen rays will also improve the symptoms of diabetes insipidus.

Pituitary given hypodermically or as a nasal spray will control, although not cure, diabetes insipidus, but it has no effect on the disease proper. Insulin will control true diabetes and is useful in malnutrition. It will cause an increase in weight and improve the anemia, but has no effect on the disease. The various other endocrine substances and glandular extracts have been found wanting. It has been noted that a



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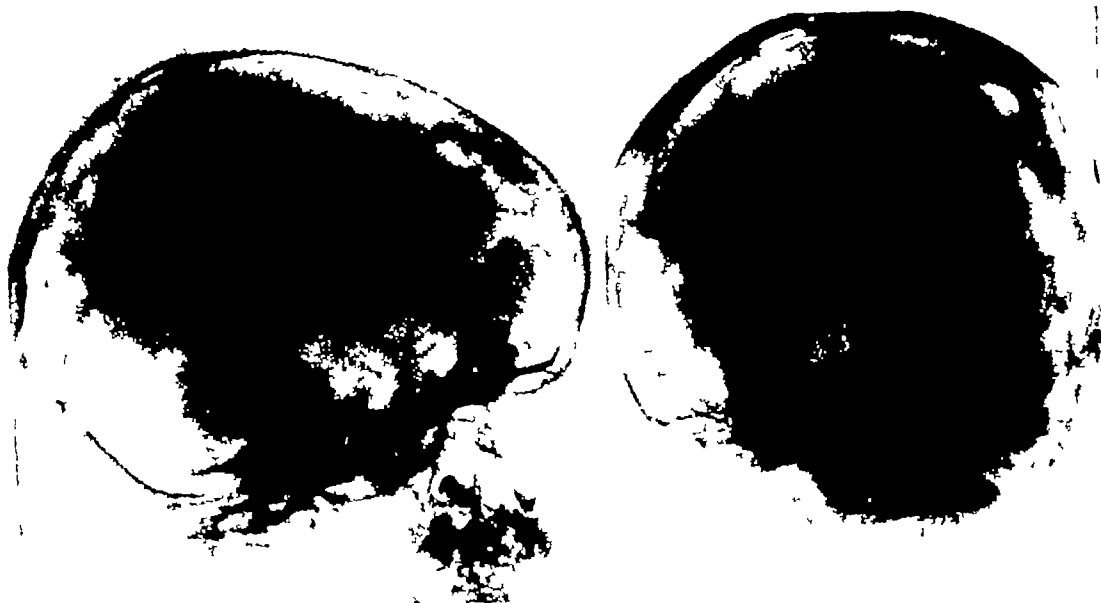
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Figs 7-A and 7-B Patient C E roentgenogram of skull six months after roentgen therapy. Many defects have completely disappeared while others show partial healing. The superior ridge of the right orbit is considerably depressed and the diameter of the orbit is smaller than on the left. This probably accounts for the persistence of the exophthalmos even after the retrobulbar fat pads have been resorbed.

low blood cholesterol exists in cases of hyperthyroidism, and on that basis the use of thyroid extract has been suggested, but that, however, has not proved effective. A low fat diet appears logical, especially in view of the fact that lesions similar to those found in Schuller-Christian's disease have been produced experimentally with a high cholesterol diet. In practice, however, it has shown no influence. Other modifications in diet, administration of irradiated food, cod liver oil, liver extract, and high calcium diets were equally ineffectual in modifying the disease processes.

Prognosis—The outlook is now considerably brighter than heretofore anticipated. One of Schuller's cases is well after 20 years. Christian's case of a 5-year-old girl, reported in 1919, is well after 16 years.

Of Rowland's 14 cases, seven are still alive. Sosman reported nine additional cases and seven of these are still alive. The older the individual, the better the prognosis. It appears that a certain tolerance is acquired as the child grows older, or that the provocative lesion heals and disappears. Therefore, if these were early

stage can be tidied over, the prognosis is good.

CASE REPORT

C E, Jewish, female, 19 months old, was referred on Sept. 20, 1932, complaining of a lump situated just above the outer portion of the right orbit. The mass was one-half inch in diameter, semi-hard, painless, and adherent to the underlying bone. There was a slight ptosis of the right upper eyelid. There were no other complaints.

The child was born on Jan. 4, 1931, at full term, normal delivery, and weighed seven pounds. She was breast-fed to nine months and walked at ten months. The teeth appeared at normal intervals. At five months she had chicken pox, and subsequently had occasional colds from which she fully recovered. There is one sister (seven years older) who is well, and her parents are well.

Three months before admission (16 months of age), the mother noticed a slight drooping of the right eyelid. Several weeks later, a small lump appeared on the forehead at the upper and outer border of

the right orbit. This lump slowly increased in size until Sept. 20, 1932, when it was one-half inch in diameter. Roentgen examination of the skull at the time revealed a round, sharply demarcated, rarefied area about one-half inch in diameter in the right frontal bone, involving the upper and external rim of the right orbit.

Five weeks later, on Oct. 26, 1932, another roentgen examination showed the rarefied area to have increased in size to about three-quarters inch. The mass on the forehead was also larger but the ptosis of the right eyelid remained about the same. There was no exophthalmos, polydipsia, or polyuria. A presumptive diagnosis of xanthomatosis of the Schuller-Christian type was made.

Surgical removal of the mass was advised and carried out a few days later. The pathologic report follows:

Microscopic findings reveal a very cellular tissue closely resembling that of an epulis. There are very many giant cells of the epulis type, some large, others quite small. The other cells have a scanty cell body and round or oval vesicular nuclei. In the periphery, some fibrosis is noted and there is a mingling of some fibroblasts and lymphatic cells with those described above. Nowhere are any lipid-containing cells present. There is no evidence to classify the lesion with anything but the bone marrow hyperplasia occurring in parathyroid disease.

The child was thereafter occasionally seen by the family physician, who noticed the reappearance of the mass on the right forehead four months after removal (two years of age), and the presence of a slight exophthalmos of the right eye.

The child was again seen on May 8, 1934 (three years six months old), at which time the most pronounced change was in the appearance of the right eye. The right eyeball was pushed forward, downward, and medially. The palpebral fissure was widened, but the child was able to close her eyelids. The mass on the forehead had reappeared and was now fairly large and flat. Palpation of the scalp revealed several other flat irregular defects in the parietal

and temporal regions. The edges of these defects were sharp and resistant, like the rim of a glass. A slight rhythmic diffuse pulsation was palpable over the temporal defects. There was no pain on slight pressure (deep pressure was avoided).

X-ray examination of the skull showed marked changes. There was a large area of rarefaction in the right frontal bone, beginning at the mid-line and extending above the right orbit to coalesce with another rarefied area in the right temporal bone. The frontal process of the right malar bone was completely destroyed. Several other large rarefied areas were present in the left temporal and occipital regions. The edges of these defects were sharp and there was no evidence of any new bone reaction.

The periosteum was elevated in several places producing an undulating surface. The entire thickness of the right temporal bone was involved. These findings are typical of the geographical skull of Schuller-Christian's disease. The bones of the chest, trunk, and extremities were not involved.

During June and July, 1934, roentgen therapy was administered to the parathyroids, using two portals, 200 kv., 4 ma., 40 cm. distance, 0.5 mm. Cu and 1 mm. Al filtration for a total of 3,440 r units divided in 8 weekly treatments. These treatments, however, failed to affect the cranial defects. In fact they grew larger, as revealed by a roentgen study made six weeks later.

The child was admitted to the hospital on Aug. 28, 1934, for further study. She also complained at this time of an occasional nocturnal headache, which was not confined to any particular place in the head. Exophthalmos of the right eye was present. There was no polydipsia, polyuria, or soreness of the mouth. The child was well nourished, fair skin and hair, weighed 39 pounds, and was 39.5 inches tall. The scalp was irregular in contour, and several sharp-edged defects were palpable in the frontal and temporal regions. The fontanelles were closed. The eyegrounds were normal and there was no disturbance of vision. The pupils reacted normally. The mouth was normal. The lungs and heart

were normal. The liver and spleen were not enlarged. Neurologic examination was negative except for the loss of the right plantar reflex. Blood pressure was 74 systolic, 45 diastolic.

The roentgen findings at this time showed, in addition to the skull involvement, a rarefied area the size of a nickel in the left ilium.

The fluid intake and output were as follows:

	Intake		Total	Output		Total
	Day	Night		Day	Night	
8/30/34	24 oz	18 oz	42 oz	8 oz	7 oz	15 oz
8/31/34	30	18	48	15	22	37
9/1/34	42	18	60	45	14 5	59 5
9/2/34	34	18	52	20	6 5	26 5
9/3/34	21	15	36	20	10	30
9/4/34	29	15	44	15	4	19

The total intake was never more than 60 oz in 24 hours, and the output never more than 59 5 ounces.

Urine Examination

	8	10	12	2	4	6	8	Night	Average
Mosenthal	1 001	1 006	1 003	1 010	1 006	1 006	1 001	1 010	1 005
Spec grav	500	300	325	50	200	200	75	450	2100
Amt c.c.									

At other times the specific gravity varied between 1 015 and 1 027.

Bence-Jones albumin—negative.
Aschheim Zondek test—negative.
Chlorides 1 56 grams/100 c.c. as NaCl
P S P

1st hour 35

2nd hour 25

Total 60

Blood Examination (Sept 4, 1934)

R B C. 5,250,000
Nyelocytes 0
Lymphocytes 39%
Histiocytes were not found

Platelets 520,000
Staff forms 2
Monocytes 5%

W B C 4,800
Segmented forms 51
Eosinophiles 3%

Blood chemistry

Glucose 100
Chlorides 520
Creatinin 1 26
Uric acid 4 8
Calcium 17
Total fats 755
Cholesterol 200
Cholesterol esters 132
Phosphorus (whole blood) 38 8
Phosphorus inorganic 5 2
Total acid sol phosphates 23
Lipoid phosphates as lecithin 412
Lipoid phosphates 16 7
Albumin 4 8
Globulin 1 5
Urea nitrogen 11 1
Non protein nitrogen 25

8/30/32

100
520
1 26
4 8
17
755
200
132
38 8
5 2
23
412
16 7
4 8
1 5
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2/19/35

74
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The figures in the second column were obtained five months after the irradiation of the head and pelvis. Calcium was unusually high when the bone defects were

greatest, and this might be accounted for by the presence of active bone absorption during that period. It returned to a high normal following irradiation, when recalcification was in progress.

Treatment—Roentgen therapy was administered to the head, using four ports 140 kv, 4 ma, 40 cm distance, and 3 mm Al filter, 600 r units to the frontal and occipital regions. The pelvis received 400 r units in divided doses, using 180 kv, 4

ma, 40 cm distance, 0 5 mm Cu, and 1 mm Al filtration. Epilation began in three weeks, and the hair returned in ten weeks. The defects in the cranial bones began to

recede in about four weeks and continued to do so, as revealed by repeated roentgen studies, until the improvement is now about 90 per cent. Many of the skull defects have completely disappeared and have been replaced by what appears to be normal bone. There are still several incompletely healed defects in the temporal and occipital regions and in the right wings of the sphenoid.

In the healing of the defects about the right orbit, the superior margin formed by the frontal bone has been depressed, resulting in a decrease in the vertical diameter of the orbit. Likewise, there has been a slight narrowing of the orbit due to a thickening of the frontal process of the malar bone. The orbit is, therefore, considerably smaller than the one on the unaffected side and too small for the proper recession of its contained eyeball. The depression of the superior margin also prevents the eyeball from reaching the level of the normal eye. This, we believe, is in a great measure responsible for the persistence of the exophthalmos even after other symptoms have either disappeared or improved. The defect in the left ilium has healed.

In addition to irradiation, the child was given cod liver oil, powdered liver, and a high calcium diet, but we do not think that these exerted any influence on the course of the disease.

SUMMARY

A case of Schuller-Christian's disease in a Jewish girl, with onset at 16 months of age, is herewith reported. Drooping of the right eyelid, followed by a small lump on the forehead, were the first signs presented. Roentgen examination revealed a circumscribed defect at the site of the lump. Biopsy of the tumor revealed an osteitis fibrosa without the presence of foam cells. This fibrosis occurred early in the disease without the influence of radiation. There was no evidence of diabetes insipidus or other lesser symptoms. The child was next observed after an interval of two years, when the cranial defects and exophthalmos were markedly aggravated, but

polydipsia and polyuria had not appeared. Roentgen therapy applied to the parathyroids did not seem to retard the progressive development of the cranial defects. Roentgen therapy was instituted over the bone lesions with gratifying results. At present, 90 per cent of the defects have disappeared. Exophthalmos, although somewhat improved, is still persistent. This, we believe, is in a great measure due to a constriction of the orbit, the result of a hyperplastic deposit of new bone at the site of the defects. Other dietary and glandular therapies did not influence the disease. The child has continued to develop mentally and physically at a normal rate.

We wish to express our appreciation for the valuable co-operation given by Dr Mendel Jacob, Director of Laboratories at the Beth El Hospital.

CONCLUSION

Cranial and other bone defects present in Schuller-Christian's disease can be definitely controlled and healed by irradiation of the lesions. The lipogranulomas cause a softening, spreading, distortion, and deformity of the bones involved, and these deformities become permanent when the processes of repair heal the defects. This is the reason for the persistence of the exophthalmos, if the bones forming the orbit have been extensively involved. The orbit becomes too small for the proper accommodation of the eyeball. It is, therefore, important that radiation therapy be instituted as early as possible, for the smaller the defects, the less the resultant distortion. If the disease can be recognized and therapy instituted before the eyeball has been displaced, exophthalmos would in all probability be avoided. Just how radiation influences the disease is not known. It probably affects the phagocytic properties of the reticulo-endothelial cells, preventing the storage of lipoids and their formation of lipogranulomas and permitting healing processes to function. As the various symptoms are directly caused by the storage of lipoids and the presence of lipogra-

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Chlorides 1 56 grams/100 c.c. as NaCl
P S P 1st hour 35

2nd hour 25

Total 60

Blood Examination (Sept 4, 1934)

R B C 5 250 000

Nyelocytes 0

Lymphocytes 39%

Histiocytes were not found

Platelets 520 000

Staff forms 2

Monocytes 5%

W B C 4,800

Segmented forms 51

Eosinophiles 3%

Hb 85%

Blood chemistry

Glucose
Chlorides
Creatinin
Uric acid
Calcium
Total fats
Cholesterol
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Lymphocytes 39%
Histiocytes were not found

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Staff forms 2
Monocytes 5%

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Segmented forms 51
Eosinophiles 3%

Hb 85%

Blood chemistry

Glucose
Chlorides
Creatinin
Uric acid
Calcium
Total fats
Cholesterol
Cholesterol esters
Phosphorus (whole blood)
Phosphorus inorganic
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Lipoid phosphates as lecithin
Lipoid phosphates
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SOME LAWSUITS I HAVE MET AND SOME OF THE LESSONS TO BE LEARNED FROM THEM¹

(Second Installment)

By I S TROSTLER, M D , F A C R , F A C P , Chicago

AN IMPORTANT MICHIGAN FLUOROSCOPIC FOREIGN BODY CASE

IN the following case, tried twice, four radiologists of good experience and standing testified as experts, all agreeing that, from the records and everything they could learn, there was no liability, however, the jury, because they did not and could not understand, found for the plaintiff in both trials. This case is so important that it is reported in detail.

In 1926 the plaintiff, a man of 42, more or less addicted to the use of alcoholics, according to the testimony, got a small fragment of a needle in the sole of one of his feet. He went to the defendant physician, who, finding the foreign object in a roentgenogram which he made, tried to localize it and remove it under fluoroscopic (cryptoscopic) control. Some time afterward the plaintiff went to a hospital conducted by the State and there, after a diagnosis of dry gangrene, had the foot and leg amputated. The surgeon who did the amputation did so on the alleged diagnosis of a third degree roentgen dermatitis.

Roentgenograms made of the amputated limb showed calcific deposits in both anterior and posterior tibial and dorsalis pedis arteries, and the pathologist's microscopic diagnosis was Monckeberg's fatty degeneration of the middle layers of the arteries (the so called corduroy artery), with marked calcium deposit in both the tibial arteries and the dorsal artery of the foot. The pathologic examination and report were by the late Aldred Scott Warthin.

Suit was brought against the physician

and, considering the importance of the case, after I had been in consultation with the defendant's attorneys, it was decided advisable to take not only another roentgenologist along as a witness, but also a pathologist to testify regarding the character of the arteriosclerosis found in the amputated leg.

All the testimony agreed that the dorsum of the foot only had been exposed to the x-rays and that the ulcer or alleged x-ray injury had occurred on the plantar surface of the foot, in and around the operative incision.

The hospital history (as given by plaintiff, of course) reads as follows: "G C, age 42. Last July patient ran a needle into left foot at base of great toe. X-rayed and operated without success. Twelve days later repeated under fluoroscope. Needle not found but fluoroscope used for four hours. One week later burn began to develop on sole of foot."

"Dr C examined foot and advised amputation. Amputated left leg below knee."

"Pathological Diagnosis: *Area of dry gangrene*. Marked Monckeberg calcification of arteries. Secondary pyogenic infection. Ulceration. Diffuse fibrosis. Report on bone later. After decalcification, no osteomyelitis found. Fibrosis of periosteum. Osteoporosis of bone. No active process."

(Signed) A S WARTHIN "

The late lamented P M Hickey, M D, was put on the stand and, after qualifying, testified as follows:

Q Will you please tell the jury how you measure the x-ray current—the strength of the x-ray current?

A The strength of the x-ray current is measured by a meter which registers the

¹ The Editor desires to state that the questions and answers herein are transcriptions of court reporter's notes and have to be printed in form as received without normal punctuation or phrasing. As printed they serve to show the nature of court testimony although they do violence to grammatical rules.

nulomas, the prevention of such storage is the prevention of resultant symptoms. There is no evidence to indicate that radiation will prevent or alter the lipoidemia.

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on Monday and again on Tuesday for the same length of time with the same current and spark gap and a week hence and again a week from then, you may state whether or not that would be a safe exposure. Would that illustrate the principle of cumulative exposure? A Yes.

Q You may state whether or not, Doctor, there is any safety precaution to be used regarding cumulative exposure and the distance in time between them in the use of the x-ray.

A If there has been a full exposure on a given day, it is customary to wait for two or three weeks before giving the second exposure. If there has been only a fractional dose given on the first day, then the rest of the fractional dose could be given at any subsequent time. The effect of the x-rays stays on the person for some time.

Q How many milliamperes current and what spark gap would be necessary to produce a picture of a foreign body in a person's foot that would be clear enough for you to see and diagnose?

Mr C The defendant objects on the grounds that he has not got all of the elements necessary on which to pass an opinion.

The Court I don't know if he has or not. Maybe the witness can give an opinion.

Mr C I am raising the question.

The Court We will leave it to the witness.

The Witness Your honor, I would like to ask if the use of "picture" means the film or fluoroscope?

Mr C I mean the fluoroscope.

A The clearness of the fluoroscopic image depends upon the clearness of the individual's eyes. If you should attempt to make a fluoroscopic examination in this room, you could use a tremendous amount of current and not get a correct image, because your eyes are influenced by the light from the window. It takes at least fifteen or twenty minutes' preparation of the eyes so that they become sensitive to sense the very slight shades of the fluoroscope.

Q Assuming that the room is dark with

only the light from the anode and cathode burning and the eye has been accustomed to the light of the room as would ordinarily be the case where the operator is trying to get an efficient picture on the fluoroscope.

Mr C We have the same objection.

The Court If he can answer the question, he may.

A You want the quality of the current?

Q Yes.

A Ordinarily, we use about four or five inch spark gap, that measures the voltage or the intensity of the current and not the quantity. The quantity of the current would be measured by milliamperes which would be from three to five milliamperes and the tube distance (by that I mean the distance of the target of the tube from the screen), the fluoroscope screen, I would say twelve to fifteen inches—that ought to give a clear image of either a hand or foot.

Q Will you tell us the difference between accumulative exposure and continuous exposure?

A Accumulative exposure is equivalent to the actual number of minutes the x-ray was on the part examined. A continuous exposure for a certain length of time is the same as the same amount of exposure after deducting the intermissions in which the current was cut off.

Q About what is the time between an exposure to the x-ray of four to five milliamperes current and the time when an erythema or burn appears?

A We sometimes have at the end of 24 hours what is called the first appearance of redness which is usually quite short. The true erythema or redness usually comes on between the tenth and the fourteenth day, sometimes as late as the eighteenth day.

Mr C Did I hear you say in 24 hours this appeared?

A The primary or round erythema which does not appear in all cases. The burn usually makes its appearance along about the end of the second week. I have seen all kinds of x-ray burns, acute and chronic.

Q Assuming that this plaintiff acciden-

quantity of current which goes through the x-ray tube. The measure of that is told in thousandths of an ampere, technically called a milliamperere.

Q So the strength is so many milliamperes? *A* Yes, sir.

Q How do you measure the time of exposure with reference to the milliamperes?

A We measure it in milliamperere minutes or seconds.

Q How do you compute the milliamperes in seconds?

A It is computed by dividing the number of actual exposure minutes by the number of milliamperes which are being delivered in the tube.

Q Very well. What is the anode of an x-ray?

A The anode of an x-ray tube is what is commonly known as the target, which is a solid piece of metal, usually tungsten, which receives the electric current, known as the electrons, and the anode is the point in the tube at which the x-rays are generated or formed. The rays scatter from the anode like the light from a candle. There is a dark side and a lighted side of the anode. The x-rays radiate in every direction from the front half. The tube is a round glass globe containing the anode and the filament. This contains the cathode and the anode. About the 4th or 5th of February I had occasion to x-ray the plaintiff's foot. One of my assistants did the work under my direction. There was a piece of metal or foreign body near the joint of the great toe. I have used the fluoroscopic method of diagnosis a great deal. The x-ray is used for locating foreign bodies, bullets, pins, needles, etc., in the body, for the examination of bones as to whether broken or diseased, also for the examination of the chest—to determine the condition of the heart and the lungs, and also for the examination of the organs of digestion—the stomach and intestines. Yes, also for treatment.

Q What, if you know, is the maximum safe period of exposure with unfiltered rays with the tube at a distance of ten or twelve inches from the member?

A Well, I would like to know the quantity and what we call the voltage of the tube or equivalent spark gap.

Q Say the current was of sufficient strength to make a picture clear enough that the head of a needle could be seen in the foot.

A Well, do you speak of that as being on a plate or on a fluoroscopic screen?

Q On a fluoroscopic screen.

A The ordinary current we use for such an examination would be two to five milliamperes and have an equivalent spark gap of five inches and the length of time which it would be safe to use such a current would be from eight to twelve minutes, or, granting it was four milliamperes in current, that would be about 48 milliamperere-minutes—the actual time by the clock would be from eight to twelve minutes.

Q That is, 48 milliamperere-minutes is equal to 8 minutes?

A If you were using 4 milliamperes current, yes, sir.

Q You say anything above that would be unsafe?

A With the ordinary individual, yes.

Mr F The defendant objects because plaintiff's counsel has not stated in the question, the factors that the witness is assuming.

Mr G The witness has already stated the factors.

The Court All right, let it stand.

(Witness continuing) By the ordinary individual I mean the one who has a normal skin and in the usual state of health.

Q What do you mean by "cumulative exposure?"

A I mean that if there has been an exposure of, say, 10 milliamperere-minutes on one day that if there were 10 milliamperere-minutes given the following day, it would be equivalent to a little less than 20 milliamperere-minutes given in one day.

Q And why is that, Doctor?

A Because the effect of the x-ray persists for several days.

Q Supposing that the operator used a 10-milliamperere current with a 4-inch spark gap and used it for 10 milliamperere-minutes

The Court I notice that you used the words "Victor x-ray machine"

Mr G Fisher

The Court You said "Victor" I notice also you have in there, regarding the first day and a period of time stated wherein the current was on continuously for more than one period of twenty minutes I don't believe that the evidence sustains that Strike out of your question any references to any definite time on the first occasion and I will permit the Doctor to answer the question

Mr G Consider the question as the court has suggested, eliminating any specific period of time on the first exposure

The Court On the first occasion the plaintiff visited the office of defendant

Mr C We want the record to show that defendant objects to the amended question

The Court That is, your objection you stated, to this question may stand as the objection to the amended question?

Mr C Yes

The Witness Well, I think it is rather hard to do mental arithmetic problems as to the number of minutes the exposure actually took place If you could summarize and give me the number of minutes they were, that the x-ray was actually applied I would be glad to try to answer the question

Q Do you mean by summarized, the total time?

A Yes, the question is too indefinite to give an answer

Q The question includes one period of constant exposure of twenty minutes, that is, time minutes The evidence is clear, I think as it can be, and that is the estimated time of the witnesses who saw the time and that estimate is all—an exposure of ten minutes and two to five minutes' rest and an interval of fifteen minutes and two to five minutes' rest and all the time during the whole period the exposure was greater than the time the current was off

The Court Is it is on the last occasion?

Mr G Yes

The Court I will permit the Doctor to answer the question

The Witness Under the conditions of the question I will answer that the exposure was beyond the safe limit

Q Assuming then that after the expiration of one week from the time plaintiff was exposed in the manner indicated, the skin on the top and bottom of plaintiff's foot grew red and became inflamed and blisters or blebs appeared on the bottom, that the blisters or blebs were both large and small and contained a light colored serum, that the skin broke down and sloughed away, and became a discharging ulcer, half of the plantar surface being destroyed, that after six or seven weeks of treatment the foot showed no signs of healing but that it would for a time partially heal and then break down again, that the left foot and part of the left ankle presented a diffuse process, which spared only the heel, that the uppermost portion of this process was characterized by dusky induration with no gross break in the continuity of the epidermis, that over the anterior half of the foot, especially on the plantar surface and the medial portion of the dorsum, there was a large area of ulceration, that the upper portion of the ulceration was not continuous, but was made of pin-point to quarter-dollar sized ulcers, that these ulcers were irregular in outline and were not very superficial, that the bases were covered with a mild seropurulent exudate, that on the plantar surface the ulceration was much deeper and that the entire anterior two-thirds of the foot was covered by one large ulcer, that the borders were very irregular and varied in conformation from that of a definitely punched-out border to a definitely shelving border, that the base was covered with a purulent discharge, which was somewhat foul, that on the plantar surface and over the first metatarsal phalangeal articulation was a widely gaping incision, that there was no definite capillary stasis in the surrounding skin, that there was considerable induration that in the areas of unbroken skin surrounding the ulcers there was considerable vesiculation, which was both discrete and confluent, that the plain-

tally ran a part of a needle approximately one-fourth inch in length into the bottom of his foot at the point just under the base of the great toe, that the plaintiff felt little inconvenience and drove a truck thereafter for about four days, that during the four days no pain was felt and no inflammation or swelling appeared, that the needle in the foot was felt only slightly when pressure was brought to bear upon it, that there was no noticeable break in the skin at the place of the entry and the plaintiff wore his shoe and sock and continued about his work in the usual manner for the four-day period between Sunday and Thursday night, that on Friday about 9 30 in the morning plaintiff consulted the defendant, a physician, that defendant took two x-ray photographs of the injured member in an attempt to determine the location of the foreign body, that thereafter defendant made an incision in plaintiff's foot about one-half inch, under a local anesthetic, that the developed plate showed a good picture of the part and of the foreign body, that the defendant exposed the plaintiff's foot to the x-rays thereafter, using a fluoroscope, attempting to remove the needle for a period of two hours or so, alternated between the fluoroscope and another operating table without using the fluoroscope and that the wound was dressed and the plaintiff discharged, that the longest exposure on that occasion was approximately fifteen minutes and that there was more than one fifteen-minute exposure, that thereafter in approximately twelve or fourteen days the wound had healed to a large extent and had been during the time dressed every other day by the defendant, that there was no infection on the foot at any other place except at the point of incision, that the defendant pronounced the foot sufficiently healed to justify another attempt to locate and remove the needle, that at or about 9 30 in the morning on or about Sept 18, 1925, the defendant injected a local anesthetic into the plaintiff's left foot and incised the foot on the top, between the great toe and the second toe, that the defendant at-

tempted for approximately half an hour or less to remove the needle but failed, that at the time that defendant was using a tube stand and the rays of the machine were penetrating the patient's foot from the top with the tube approximately ten or twelve inches from the foot, that at about ten o'clock defendant placed plaintiff's foot under the x-ray using a Victor x-ray equipped with a Coolidge tube that the rays were coming out of the opening from the center of the tube and that the rays were not filtered, that the tube was from eight to ten inches from the exposed member, that the defendant used a hand fluoroscope for a time, that the machine produced a clear picture of the foreign body, clear enough to enable a person to see the aperture in the head of the needle, that he continued to operate on plaintiff's foot for a period of about twenty minutes after which time he changed the position of plaintiff and placed the foot before another tube and about ten inches distant therefrom, that the plaintiff was at that time on what is known as a reclining table and his legs placed so that his foot was between the tube and the fluoroscope, that defendant attempted to get hold of the foreign body with surgical instruments continuously with frequent interruptions of between two to five minutes and one of about twenty minutes until approximately one o'clock in the afternoon, that plaintiff remained on the operating table without interruption with his left foot under the ray for a period of about three hours with the exception of intervals of a few minutes' duration as above stated, that during all this time there was no protecting medium on plaintiff's foot—you may state, Doctor, whether or not in your opinion the exposure of the plaintiff's foot to the x-ray in the manner indicated was proper or improper?

Mr F To which the defendant urges the previous objection That the form of the question is improper, that the question lacks elements sufficient to scientifically answer the questions and, furthermore, the question is too long to be comprehended by the jury

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Mr F To which the defendant urges the previous objection That the form of the question is improper, that the question lacks elements sufficient to scientifically answer the questions and, furthermore, the question is too long to be comprehended by the jury

inches, is in continuous operation for three hours, will you state whether or not the tube would be functioning at the end of three hours?

A I think not

Q Using the factors of 4 milliamperes and 4-inch spark gap with the rays passing from the top to the bottom, if a burn occurred, where would you expect to find that burn? On the top or the bottom of the foot?

A The tube at the top of the foot?

Q Yes

A We would expect the burn to show its greater effect on the top of the foot. If it was exposed only on top, we would expect the greatest brunt of the exposure to appear on the side of the foot toward the tube. We would expect the burn to show its greater effect on the top of the foot.

Q The question was asked, could you give a 20-minute exposure with 4 milliamperes and 4-inch spark gap for 20 minutes—would it be any different from an exposure over a period of 20 minutes that was intermittent and in which the fluoroscope was used and taken off?

A Yes, it would be less severe according to the number of minutes you subtract from the actual exposure.

Re-direct Examination by Mr G

Q If the exposure was greater on the bottom of the foot, the fact it being equal, we would expect the greater evidence of the burn to be on the bottom of the foot?

A No. The bottom of the foot stands much more x-rays than the top.

Q Supposing that the fluoroscope was placed on the shin or on the leg, the tube was placed back here and the rays penetrating through the bottom of the foot of sufficient strength to give a good picture, could the person, if he were conscious and alive, look through that side of the fluoroscope and see the picture?

A The person whose foot was being examined could not.

Q How many degrees of an x-ray burn are there?

A I think we usually classify them in

three classes first, slight redness, which persists for a comparatively short time, which might be compared to the irritation of a sunburn, second, the type of burn where there is the production of blisters, similar to what one gets from a hot water burn, third, a deep burn, where the tissues lose their vitality and remain in an unhealthy condition for a considerable length of time.

Q What is the best treatment for an x-ray burn?

A Well, that depends, of course, a great deal upon the severity. If it is very resistant, usually the getting rid of the tissues which do not heal and then covering with a skin graft.

Q Would a skin graft on the foot in the conditions of the foot I have described and indicated as being present in this case, be efficient?

A According to the description you have given, I should think possibly not.

Q Why not?

A Well, the essential feature of an x-ray burn is the fact that blood vessels are damaged—the small blood vessels—so that the action of the individual blood vessels is decreased—a decreased amount of blood to the parts. If you have decreased action—no blood to the part—you don't have the conditions then which are favorable for the making of a skin graft.

Q A skin graft would be more difficult on a large area than on a small area?

A Yes.

Q Is there any cure for an x-ray burn of the degree you have described as a third degree?

A Well, if the blood vessels have been permanently damaged so there is an interference in amount of blood and proper amount of nourishment, I don't think there is, without cutting down to the healthy tissues.

Q Dr Hickey, Mr F asked you whether or not, if the rays, the current, was kept on for three hours would be efficient, you answered that it wouldn't because it would get so hot it would lose its efficiency, and I asked if, in the event of intervals the

tiff suffered excruciating pain of a burning sensation continuously, except infrequent interruptions when the pain would subside for a time and would then recur, that there was no appreciable swelling of the injured member, no appearance of red streaks running from the ulcerated area, that the plaintiff had a normal temperature and felt no fever or sickness except the pain and suffering described—with these facts in mind, Doctor, and assuming the description of the exposure in the preceding question, you may state what, in your opinion, caused the condition on plaintiff's left foot

A I think the description which was just given would apply to an irritation from an x-ray exposure

Cross Examination by Mr F

Q Would the description just given by Mr S apply to any other disease than an ulcer from an x-ray burn?

A I think some forms of chronic inflammation might simulate that

Q What do you mean by idiosyncrasy and its application in x-ray?

A Idiosyncrasy is recognized in science and as we usually understand applies to some people who are more sensitive to the exposure of x-ray, as some people are more sensitive to the action of the sun. A physician may follow out the established formula adopted by the profession for the x-ray and use all the proper factors calculated to be safe and proper and yet x-ray burns do occur, because of idiosyncrasy

Q Then it is a fact that a physician using ordinary care and skill and employing the proper factors in x-ray as described, may nevertheless burn the patient?

A Yes, sir

Q Dr Hickey, can a patient look at the tube, a layman, who is not accustomed to the x-ray room, looking at the tube and tell whether or not the x-rays are being emitted therefrom?

A Not with a Coolidge tube, because the x-rays are invisible to the unaided eye

Q I will ask you if a patient is placed in a reclining position and a Coolidge tube

is placed about fourteen inches in front of his foot between the knees and the foot fourteen inches from the tube, the bottom of the foot up and a hand fluoroscope is held at the bottom of his foot, can the patient looking down in a vertical position and direction see the shadow that would be caused by a foreign object in the foot? Can he see that shadow on the fluoroscopic screen?

A If I understand your question correctly I think not, because he would be looking at the back of the fluoroscopic screen

Q Assuming that the patient is in a reclining position and the x-ray tube is placed in this position [illustrating tube pointing away from patient]?

A Yes

Q Fourteen inches away from the bottom of his foot, then with the aid of the hand fluoroscope and the tube in this position, could the patient back here [illustrating] see the object, the shadow of the object?

A I do not think so

Q Is it not a fact regarding the cumulative effect of x-rays, that 50 per cent of the rays' effect disappear in three days after the exposure?

A We figure that 50 per cent of it is lost toward the end of the first week

Q Isn't it a fact that perhaps 94 per cent of it is entirely gone at the end of 17 days?

A The average patient, yes, I would say so

Q Suppose, Dr Hickey, that a patient is subjected to the x-ray at a target distance of ten or twelve inches and assuming a spark gap of 4 inches and of 5 milliamperes and that the exposure is continuous for two hours, when would you expect the primary erythema to develop, if one developed?

A We would expect it to develop some time within the first 24 hours

Mr G That is with a two-hour exposure?

Mr F Yes, two-hour exposure

Q Dr Hickey, if a Coolidge tube using a milliamperage of 4 and a spark gap of 4

fluoroscope to locate foreign bodies in a patient's foot?

A It is

Q During such fluoroscopic examinations, are the x-rays filtered?

A Usually they are not filtered or only lightly, slightly filtered

Q Suppose, Doctor, that, using the following factors, 4 milliamperes of current, 4-inch spark gap, at a distance of 14 inches for a period of 6 minutes, you may state whether or not that would be the customary and ordinary practice

A I would say that that would be the customary and ordinary practice and safe if used once

Q Would it be more or less than the ordinary practice and would it produce a burn on an ordinary individual?

A It would be giving or applying less than what is the ordinary practice, decidedly less. That amount of x-rays would not produce what you are pleased to call a burn, but what we prefer to call a dermatitis, on the skin of an ordinary individual

Q Doctor, what do you mean by idiosyncrasy to x-rays?

A Certain people are hypersensitive to the x-rays, just as some people are more sensitive than others are to the sunlight, the rays of the sun. Some people tan while others burn when exposed to the direct rays of the sun. That unusual tendency to burn is what we call idiosyncrasy in this particular situation. It is one form of idiosyncrasy. We have other forms of idiosyncrasies like those in regard to foods, drugs, and other things

Q Is there any way by which you may determine beforehand if a person has this idiosyncrasy to the x-rays?

A No, there is no known way to determine the presence of idiosyncrasy to x-rays or any other agent, before or in advance of a test

Q Would you expect a reaction or burn with the use of the x-rays if the factors just given you were used? If not, how would you explain the occurrence of a reaction? Discuss it in your own way so that we may learn about it

A With the exposure for which you stated the factors, I do not see how a reaction in the nature of a dermatitis could occur, except in the presence of the most extreme and violent idiosyncrasy. If such a thing did occur, it would be due to idiosyncrasy, which is the unusual effect of the x-rays (in this instance) upon an individual who is particularly susceptible to these rays

Q Doctor, if the hand of one individual and the foot of another were exposed to the same factors and under the same conditions, and at the same time, which, if either, would be burned first or most?

A If it was the back of the hand and the top or dorsal surface of the foot, the effect, if both persons were normal, would be the same. It would be identical if they both had equal sensitivity to the x-rays. On the other hand, if the back of the hand and the sole or plantar surface of the foot were exposed under the conditions you described, the sole of the foot would be far less likely to be affected, because the sole or plantar surface of the foot will tolerate about three or four times the amount of x-rays—in an ordinary individual—than will the back of the hands or the top or dorsal surface of the foot. If now, the foot showed evidence of irritation or dermatitis, under the conditions you stated, I would unqualifiedly say that the owner of the foot had a definite hypersensitivity or idiosyncrasy

Q If a patient is placed in a reclining position on a table such as this one and the foot is held in front of the x-ray tube and the doctor is at the plantar surface of the foot and the factors are 4 milliamperes of current, 4-inch spark gap, 14-inch distance and the doctor studies the condition of the foot by the use of a hand fluoroscope, you may state whether or not the patient on the table could see the object, the foreign body in the foot or the shadow of a foreign body present in the foot

A The man on the table—the patient—certainly could not see the object in the foot

Q Why?

tube was turned off for two to five minutes at a time, it would cool?

A Yes, it would cool if it was off for five minutes, I think

Q How would you compute the total exposure for half a day, with the tube intermittently lighted and off?

A In computing the total exposure for half a day or any other period, we would deduct the number of minutes which the tube was not on and consider the dosage to be the sum of the minutes it was on

Q So, regardless of the intervals, if the tube was on, actually penetrating the foot for a period of time and then at rest for an hour and another exposure for a certain length of time, you would add the two exposures together to determine the effect of the x-rays on the member?

A Yes, if the séance or sitting occupied a total time of less than half a day. Considering the total exposure within half a day would not make much difference

Re-cross Examination

Q Have you ever produced an x-ray burn in a diagnostic procedure?

A In our department, we have had evidence of an irritation in diagnostic work on a patient under my observation. We had one case of a Filipino who had had a series of dental x-rays made, the exposure which was over each area was ten seconds and that was followed by a very distinct tanning of the skin, which subsided. When the Coolidge tube first came out, I had a burn of the second degree, which lasted about two weeks. The Coolidge tube was pretty new in those days. I was very much surprised that I would get a burn.

Q Assuming, Doctor, that a physician had used the following factors—4 milliamperes, 4-inch spark gap, 14-inch distance for a period of $5\frac{1}{2}$ minutes, would you say whether or not that would conform to the usual and ordinary practice?

A Yes, that conformed with the limit of safety.

Q A doctor, therefore, using these factors for that length of time would be using the ordinary care and skill?

A Yes, sir

Q Suppose a patient were exposed on the 4th of September and the pictures were taken and a little fluoroscopic work was done, and then on the 18th of September, 14 days later, the foot showing no erythema, no tanning, would he be justified in subjecting the patient to further radiation if he deemed it necessary?

A Yes

Q If on this second exposure on September 18th, the foot showing no reaction, the assistant would hold the patient's foot under the fluoroscope for the duration of the operation, his fingers being within the exposure to the x-rays and his fingers would not be at all burned and the reaction occurred on the foot, what would be your opinion as to whether or not the foot received an x-ray burn?

A Well, if the hands of the assistant were equally in the field in which the foot was, we would expect the hands to show evidence of irritation if the foot did.

Q The hand would be burned as quick as the foot?

A If it received the same amount of rays, yes.

Witness was excused

The incongruities and repeated contradictions in the hypothetical questions are so evident at this time (and were at the time of the trial) that any one can readily see that they were trying to pull the wool over good old "Pop's" eyes. He was far from well at the time, and even then agreed with what the holdings of the defendant claimed.

I was put on the stand for the defendant, and, after being qualified, testified as follows:

Q Are you acquainted with the practice of medicine and the use of the x-rays in the removal of foreign bodies in localities such as this and adjoining cities?

A I am

Q Is it customary and the ordinary practice in cities of this size to use the

* Not because of its importance but in order to place the evidence clearly before the reader my testimony is quoted verbatim from the transcript

ure of the distance the electric spark will jump in air, at different voltages. When we talk about a 4-inch spark gap, we mean that distance between two moderately blunt points. A current that will exactly jump across a 4-inch spark gap at sea level and normal barometric pressure, is produced by a certain voltage of current. The voltage that will just jump across a 4-inch spark gap will not jump across a 5- or a 6-inch spark gap. It requires a higher voltage to jump greater distances, and less voltages to jump shorter distances.

Q Assuming, Dr Trostler, that an x-ray exposure is made to a patient, in a reclining position from the dorsum of the foot, the x-rays passing from the dorsum of the foot toward the plantar surface. If a reaction occurred or a dermatitis occurred, state if the dorsum or the plantar surface would first be affected.

A The top of the foot, the dorsal surface. The part of the foot that is nearest to the x-ray tube, certainly.

Q Assuming that you would use the factors of 4 milliamperes, 4-inch spark gap, and 14-inch distance for a period of one hour and thirty minutes, would you expect a dermatitis?

A I certainly would, a good one—perhaps we better say a bad one.

Q When would you expect the dermatitis from such an exposure to first evidence itself?

A Anywhere from 24 to 96 hours, probably within 48 hours. A delayed reaction might occur a little later, but almost certainly within 48 hours.

Q Is an x-ray burn produced by heat?

A No, it is not.

Q Is it a chemical burn?

A Chemical in the sense that light is a chemical, only.

Q Explain as you understand an x-ray burn, that is what way the x-rays produce the burn.

A That is rather difficult to do, in lay language. Let us liken the x-rays to that portion of the sunlight that produces a sunburn. The principal part of the burning rays of sunlight are the ultra-violet

rays. All forms of light, either ultra-violet, infra-red, x-rays, or other light are vibrations of ether, waves of ether, and the only difference between the light or photochemical rays, the ultra-violet rays, the infra-red rays, and the x-rays is in the length of their waves. Now, the ultra-violet rays of the sunlight are identical with certain ultra-violet rays which may be produced artificially, by means of an electric arc or by other means. These produce sunburn if caused by the sun and ultra-violet burns if produced by the artificially produced ultra-violet light. The x-rays produce the same sort of burns, but without heat. This is because they are of themselves cold light or cold waves of the ether. Some of these so-called x-ray burns are almost exactly like a sunburn, while others, of the more severe type, produce much more destruction of the tissue than do the burning waves from sunlight or the artificially produced ultra-violet rays. Neither the so-called burn from the ultra-violet, the sunlight, or the x-rays are true burns. True burns are produced by heat, either dry or moist, but always heat. The skin injury caused by corrosives or escharotics are more nearly like the so-called burns that we have produced by light in its different forms.

Q Could we determine whether or not an x-ray exposure was proper if we had only two factors given? Only time and screen-target distance?

A It would be impossible to determine. Four factors are necessary.

Q And unless you have at least three of the factors, you cannot determine the other?

A If you give me three of the factors, I could determine the fourth factor to produce the effect I wanted, if that is what you mean.

Q But if you had only time and distance of the object from the target given you, you could not determine the spark gap?

A Absolutely not, any more than you could tell the price of wheat if you knew that lemons were selling at thirty cents a dozen.

A Because the fluoroscope would be between the foot and the doctor who was using it, and the x-ray tube would be between the patient and his own foot. The image of the foot, in order to be seen upon the fluoroscopic screen in the hand fluoroscope, must be between the x-ray tube and the eyes of the examiner, and unless these relations prevail and are present, the foot or the foreign body cannot be seen on the screen in the fluoroscope. Furthermore, with the hand fluoroscope, such as that one on the table, no one except the person using it can see the shadow in the fluoroscope. If you will hand me that fluoroscope, I will demonstrate more clearly what I mean.

Mr G I think that is admitted. The defendant admits that.

Mr F For the purpose of information for the jury, I would like the witness to show it.

Mr G We admit he couldn't see it.

Mr F But he testified that he did see it.

Witness The image of the object between the x-ray tube and this fluoroscope is seen on the fluorescent screen on the inside of this funnel-shaped instrument. In order to see that image or shadow of the object the eyes of the observer must be in the dark. That is why the small end is fitted with black fur, to shut out extraneous light. If now, the x-ray tube was energized, I held my hand against the large end of this funnel and held the fluoroscope to my eyes [indicating], I could see the shadow of my hand, particularly the bones of my hand on the fluoroscopic screen inside of the large end of this funnel-shaped box which we call a hand fluoroscope, but no other living person could see the shadow of my hand or the bones in it, no matter where or in what situation or position he stood or laid. Do I make it clear?

Q Can anybody look at a Coolidge tube and determine if x-rays are being emitted from it?

A Not from the side.

Q The x-rays are invisible?

A They are invisible.

Q The fact that the filament is lighted

indicates nothing if the x-rays are not burning?

A The fact that the filament is lighted indicates that the x-rays can be produced if the high tension current is turned on to the tube. If the filament is not lighted, no x-rays can be produced in the tube.

Q Dr Trostler, how are x-rays produced?

A The production of the x-rays is a complex process, not readily understandable except by those trained especially in that branch of physics. I will do my best to make it clear. The Coolidge tube is a special form of vacuum tube, of which that one on the table is an example. In order to produce x-rays two different electrical currents must be passed through it at the same time. A low voltage current—usually about 12 volts—enters the tube at the one end, the cathode end, and is passed through the filament. The filament is a coil of tungsten wire, which becomes hot because of the passage of the low tension current, just as does the filament in our ordinary incandescent lamps. Now, while the low voltage current is heating—lighting—the tungsten filament, a high tension current is passed through the tube and x-rays result. The passage of the low tension current is partly for the purpose of heating the bulb of the tube, or, rather, the vacuum of the tube, and the light from the filament acts as a track for the electric ions to pass from the heated cathode—the filament—toward the anode or other terminal inside of the tube, where the x-rays are produced by the impact—the striking against—of the ions or cathode stream on the anode of the tube. The anode or target of the tube is the heavy, solid structure in the middle of the bulb of the tube, from which the x-rays pass outward from a central point, toward the half of the tube, all passing in straight line away from the focal spot, which is the spot where the cathode stream is focussed.

Q Now tell us, Doctor, what is meant by the spark gap of an exposure?

A The spark gap or, as it is sometimes called, the equivalent spark gap, is a meas-

stances where the feet are heavily caloused, more than four times as much \-rays as will the dorsal surface or top of the feet

Q Would 60 milliamperes-minutes, 4-inch spark gap at a distance of 14 inches unfiltered, be a safe dose to the top of the feet?

A That amount of \-rays would be bordering on the danger line, and I would not administer that amount under ordinary circumstances

Q If you did give that much and there was no reaction in two weeks, would you repeat it? And when?

A If there was no reaction in two weeks, at the end of fourteen days, it would be safe to repeat it. It would be safe to give another exposure. If there was reaction, I would not give another exposure until the reaction had subsided. If it was a first degree reaction, it would subside in a few days. If it was a second degree reaction, where blisters had formed, and peeling of the outer skin, it might take a couple of weeks for it to subside.

Q What is the treatment for third degree \-ray burns?

A The treatment we are using for third degree roentgen dermatitis in Chicago is to completely excise the ulcer area as early as possible, cut out the burned area, and let it granulate a little while and then transplant skin to the granulating area.

Q How many third degree burns have you seen on the plantar surface of the feet?

A I never saw a third degree \-ray burn on the soles of the feet.

Q Do you see many \-rays burns?

A We see numerous burns.

Q Have you ever attended any other medical school than the one you named when you were qualified?

A I have. Several.

Q Are the \-rays dangerous to handle?

A In the hands of one familiar with the use of the \-rays they are not dangerous, but they are dangerous in the hands of persons not familiar with them, exactly as are many of the things which we as physicians handle daily. Morphine and

strychnine are dangerous to handle, but we use and handle them constantly.

Re-direct Examination (Questions omitted for brevity)

No person should attempt to use the \-ray unless he understands it.

Under certain conditions we may attempt to get an erythema in the use of the \-rays in the treatment of disease.

Under the best conditions and the best circumstances, some persons receive \-ray burns because of an idiosyncrasy, and there is no way known that will prevent it.

I cannot conceive of an instance in which proper surgical treatment would not be the advisable thing to do in a resistant third degree burn.

Re-cross Examination (Questions omitted for brevity)

The last burn I saw was on the back of a woman, just above the hip bones, in the pelvic region.

Any part of the body is susceptible.

I have seen burns on the neck. I have seen burns on the face and on the abdomen.

After excising the burn, the grafting of skin is a recognized treatment. It is often done.

It is not so liable to break down again if skin is grafted on the burned area, as it would be unable to heal.

Yes, quite a number of the pioneers have died because of their injuries. Some of these, like Wolfgang Fuchs, of Chicago, Dr. Myran Kassabian, of Philadelphia, and others, had skin grafted on their hands, and even after that, they had to have their hands amputated. One man had about twenty operations, and then had to go, at the end.

Yes, I speak with a great deal of feeling, because so many of these men who began the use of the \-rays at about the same time as I did, are gone, while I have practically no evidence of injury from the rays, simply because I was lucky enough to receive a slight acute burn early and from it, realized that we were handling

Cross Examination

Q Would it help you any to know that a good impression was produced on the fluoroscopic screen?

A Yes

Q Now, Dr Trostler, assuming that the x-rays were penetrating through the bottom of the foot for twice as long a time as through the top of the foot, and also after the rays penetrated through the dorsum and there was a burn, would you expect the burn to be both top and bottom, if the exposure was too great, assuming the strength of the current as Mr F has designated in his question?

A The bottom of the foot will tolerate about three times as much x-rays as will the top of the foot. That is also true of the palm of the hand, as well as the sole of the foot, due to the peculiar form of the skin.

Q You mean the outside, the epidermis?

A I mean the palms of the hands and the soles of the feet. Both of these have epidermis, but the bottom of the feet and the inside of the hands receiving radiation from an x-ray tube will tolerate approximately three times what the backs of the hands and the top or dorsum of the feet. Now, if the top of the feet received a certain amount of radiation, within safe limits, the bottom or soles of those same feet will tolerate about three times as much radiation of the same quality, without injury, under the same circumstances and conditions.

Q Assuming that there were exposures upon both top and bottom, that there was a 15-minute exposure continuous, that is, time minutes, and the distance of 14 inches with a 4-milliamperage current and 4 inches spark gap, and exposure from the top was 15 minutes?

A At what distance?

Q A 14-inch distance, and the exposure from the bottom was 30 minutes, or say 50 minutes, with intervals of from two to five minutes and would that dosage produce a burn on the bottom of the foot as well as on the top?

A Your interjection of intervals of from

two to five minutes makes the question unanswerable by me.

Mr G We will strike that out. Say there were no intervals.

A There would probably be a burn on the top and on the bottom of the foot, under those conditions.

Q Under the conditions just described, could the patient see the foreign body in his foot?

A If the x-rays were passing from the bottom of the foot toward the top of the foot, the fluoroscope being placed near the shin bone, with the room darkened, he might be able to see the bones of his foot and if his eyes were good enough to see a fragment of a needle at that distance he might see it on the fluoroscopic screen, if that screen were not covered by some other material or object. If he had the fluoroscope to his eyes the distance from the foot to his eyes would cause enormous magnification of the shadows upon the screen, and he would probably be unable to recognize anything.

Q Would you expect a 15-minute exposure at the distance given to produce an x-ray burn?

A At the voltage, milliamperage, and distance just given, I would.

Q An exposure of 32 milliamperage-minutes will produce an erythema at 14 inches?

A I am unable to answer until or unless you give me the third factor.

Q What is that?

A The spark gap or voltage.

Q Four-inch spark gap, according to the evidence in this case—it will produce an erythema?

A I say that it will not produce an erythema.

Q On what authority?

A My own. I am an authority. I am the authority to back it up.

Q Do you know Dr Hickey?

A I do. I know Dr Hickey and have a very high regard for him.

Q You say that the bottom of the feet will stand more x-rays than the top?

A The bottom or soles of the feet will tolerate more than thrice and in some in-

stances where the feet are heavily caloused, more than four times as much λ -rays as will the dorsal surface or top of the feet

Q Would 60 milliampere-minutes, 4-inch spark gap at a distance of 14 inches unfiltered, be a safe dose to the top of the feet?

A That amount of λ -rays would be bordering on the danger line, and I would not administer that amount under ordinary circumstances

Q If you did give that much and there was no reaction in two weeks, would you repeat it? And when?

A If there was no reaction in two weeks, at the end of fourteen days, it would be safe to repeat it. It would be safe to give another exposure. If there was reaction, I would not give another exposure until the reaction had subsided. If it was a first degree reaction, it would subside in a few days. If it was a second degree reaction, where blisters had formed, and peeling of the outer skin, it might take a couple of weeks for it to subside.

Q What is the treatment for third degree λ -ray burns?

A The treatment we are using for third degree roentgen dermatitis in Chicago is to completely excise the ulcer area as early as possible, cut out the burned area, and let it granulate a little while and then transplant skin to the granulating area.

Q How many third degree burns have you seen on the plantar surface of the feet?

A I never saw a third degree λ -ray burn on the soles of the feet.

Q Do you see many λ -rays burns?

A We see numerous burns.

Q Have you ever attended any other medical school than the one you named when you were qualified?

A I have. Several.

Q Are the λ -rays dangerous to handle?

A In the hands of one familiar with the use of the λ -rays they are not dangerous, but they are dangerous in the hands of persons not familiar with them, exactly as are many of the things which we as physicians handle daily. Morphine and

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Re-direct Examination (Questions omitted for brevity)

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something that did things to us, if we were not careful

Re-direct Examination (Answers only, for brevity)

To determine the three degrees of a burn—and the x-ray burn is likened to other burns for the purpose of classification we classify them into first, second, and third degree burns, but there is no sharp or definite demarcation between any two of the three degrees. First degree burns consist of an erythema or reddening of the skin, similar to a slight over-exposure to the sun, wherein the capillaries of the skin—the small blood vessels in the skin—become dilated and permit of a larger amount of blood to show through. These same small blood vessels are dilated and produce the red color in the skin when a bashful person blushes. The only great difference between a first degree burn of the *mulder type* and a blush is that the blush disappears quickly while the first degree burn lasts from a few hours to a few days. This reddening stops short of blistering. A second degree burn is from the point of mere reddening to blistering or the formation of blebs, such as are sometimes seen in a severe sunburn. The sunburn never gets beyond the second degree. A third degree burn is a deeper burn and consists as a rule of destruction of the skin and injury to the underlying tissues. These burns, or, as we prefer to call them, dermatites, when they are produced by the x-rays, usually pass through the three stages or degrees if they finally become third degree dermatites, but the interval occupied by the first or second degrees may be so short that these are not observed. Sometimes the third degree burns do not appear until quite late, in what we call a delayed reaction, but they never appear as a third degree burn from the beginning. There is always itching, stinging, and redness first.

Dr M J Hubeny was next put on the stand and testified substantially the same as the writer and at the close of the case, all concerned felt that in the spirit of simple

justice, the jury would find for the defendant physician, without leaving their seats.

All of the x-ray and pathological testimony exonerated the defendant physician when his—the defendant's—figures were taken into consideration. The only really damaging testimony was based upon the surgeon's pre-operative diagnosis, which was later disproven by Dr Warthin's microscopic report, and the testimony of Dr C C Croy, but the jury, evidently because the plaintiff had lost his foot and leg, brought in a verdict for the plaintiff with damages in the amount of \$15,000.

The verdict was so obviously a flagrant miscarriage of justice that a motion for a new trial was immediately made. This was denied, and the case was appealed to the Michigan Supreme Court, where the judgment of the lower court was "reversed and a new trial granted." Because this Supreme Court decision contains much that is important and instructive, it will be quoted entire.

"Before the Entire Bench"

"This action was brought to recover damages for alleged malpractice by a physician in the use of the x-ray.

"Plaintiff stepped on a needle and it broke off in his foot. Defendant treated him and, plaintiff claims, so burned his foot in a negligent use of x-rays as to cause him great pain and suffering and the ultimate loss of his left foot, by necessary amputation, about ten inches above the ankle. A jury awarded plaintiff \$15,000 damages. Defendant reviews by writ of error.

'At the close of plaintiff's proofs, defendant moved for a verdict in his favor. The court denied the motion. The motion was in the nature of a demurrer to the evidence and, in reviewing the denial, we must accord the testimony certainty and give it probative value within the limits of every reasonable inference the jury could draw therefrom. We find no error in the denial of the motion. At the close of the proofs defendant again moved for a directed verdict. The motion was denied.

We think the evidence presented an issue of fact for the jury

"At the trial long hypothetical questions were asked expert witnesses by plaintiff's attorney, and counsel for defendant allege error in overruling their objections thereto. It is insisted that the questions did not state scientific facts essential to be considered in giving an opinion. The experts seemed able to answer without the particular factors asserted and, we think, the assumed facts in the questions justified the rulings. A hypothetical question was asked one expert and he was requested to state whether or not, in his opinion, the exposure of plaintiff's foot to the x-ray in the manner indicated was proper or improper. The expert answered 'I would say it is highly improper.'³

"The court overruled the following objection

"The question invades the province of the jury, that the question is too long and improper to be understood by this jury that it assumes scientific facts which are not in evidence without which it is impossible to intelligently answer the question."

"The standard of care, skill, and diligence required by an x-ray operator is not fixed by the *ipse dixit* of an expert but by the care, skill, and diligence ordinarily possessed and exercised by others in the same line of practice and work in similar localities. We pass the form of the question and the nature of the answer and hold that there was no reversible error, for the reason that the question was based on the testimony of the plaintiff relative to the period he was exposed to the x-ray and which, if true (and had to be accepted as true by the expert), stated an exposure for a period even the merest tyro would know was improper, and every witness, including defendant, said such a dosage would have been improper. Defendant denied any such dosage. It should be remembered that an expert witness, in answering a hypothetical question must accept as true every asserted fact stated therein, but the

jury cannot consider the answer of the expert unless they find that the evidence establishes the truth of all such asserted facts. If the hypothetical question goes beyond the evidence, it defeats itself and affords an excellent opportunity for argument before the jury to that effect. *In considering a challenged hypothetical question we can give no thought to the weight of the testimony for, if there is any competent testimony supporting the asserted facts, the question goes to the jury.* Plaintiff's case rested upon the charge of negligence on the part of defendant in administering an excessive dosage and depended in the main upon his own testimony. The doctrine of "*res ipsa loquitur*" is not recognized in this State and, therefore, proof of the burn was no proof of defendant's negligence [author's italics]. Plaintiff had the burden of showing that he suffered an x-ray burn, occasioned by an overdosage or exposure to his foot, and that such happened because defendant failed to exercise the reasonable and ordinary care, skill and diligence possessed by others in the same line of practice and work in similar localities.

"The evidence discloses that x-ray burns do occasionally occur in the ordinary course of exposures and in spite of the highest diligence and skill to prevent them, the reason being that persons of a certain type and temperament are susceptible to a burn, while persons of a different type and temperament, under the same circumstances, will not suffer a burn. It also appears that this idiosyncrasy cannot be determined before or during the time of exposure but is manifested only by subsequent developments. Plaintiff assumed the risk of a burn from a proper exposure to the x-ray and defendant incurred the liability to respond in damages if the burn was occasioned by his negligence.

"There exists for the guidance of the operator of an x-ray machine certain formulæ. Plaintiff claimed his foot was exposed to the x-rays for two hours and a half, except for short intermissions. The x-ray, in this instance, was not for treatment, but to locate the needle in plaintiff's foot and to

³ This question involved what the plaintiff had testified to regarding matters which he could not know.

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Re-direct Examination (Answers only, for brevity)

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in arguing this case made the statement from which it might be inferred that he wants the jury to infer that *certain witnesses were induced to come here by relatives of someone connected with the plaintiff's case* [author's italics] The court holds that this is highly prejudicial to the plaintiff and the jury are instructed to pay no attention whatever to the argument made by counsel in respect to this phase of the case

"Mr C I want also to have the record show that on being reprimanded by the court, I ask the court's pardon and ask the court to charge the jury to pay no attention to the remark—that this remark was brought out by the question by plaintiff's counsel yesterday asking the jury to determine what influence it was that brought these witnesses from Chicago to testify in the case and counsel for the defendant, if he is in error in making the remark, as said by the court, asks the jury to pay no attention to the remark whatever' Is that satisfactory, your honor?"

"The Court Proceed

"We must decline to supplement the record by inclusion of the opinion of the circuit judge rendered after the case was argued and submitted here and without our consent (*O'Flynn vs Eagle*, 8 Mich, 135 See also *Varrick vs Hitt*, 65 N J Eq, 778), and at this late stage we must decline to remand the bill of exceptions for inclusion of action after the certification of the record to this court A bill of exceptions may be remanded for correction in accordance with facts existing at the time it was settled (*People vs Vanderhoof*, 234 Mich, 419) But we may not remand a bill of exceptions or the record, to have added thereto action taken in the circuit court to meet an error assigned and argued here and under advisement The rule we state may appear a hard one in this instance, but there must be a rule on the subject otherwise error may be plainly apparent on a record before us in a case argued and submitted and may then be met by subsequent action in the circuit court to cover the point

"We adopt the rule stated in *Johnson vs Couillard*, 4 Allen (Mass), 446 'Taking this bill of exceptions as allowed by the presiding justice, there is no error so palpable that it has been deemed proper to sustain the exceptions and set aside the verdict on that account alone

It is said by the counsel for the plaintiff, and we have much reason to suppose, correctly, that there is an error in the bill of exceptions and that proper instructions were given on that point But no amendment of the bill of exceptions having been offered until after the case had been submitted to us on argument by the representative counsel, we have not thought it proper at so late a stage of the case to receive any certificate to that effect without the consent of both parties, and especially in a case where the error can produce no greater evil than a new trial'

"It seems the circuit judge in denying the motion for a new trial, did not notice this point and the briefs filed with him did not mention it and, therefore, he overlooked it in giving his reasons We surely would not, before or after argument here, remand the record to enable the circuit judge to render a supplemental opinion or give reasons to meet an error assigned and much less should we countenance such action without our permission

"Upon the record before us *we must accept the showing made in the affidavit of Mr Ford and may not consider the traverse thereof in the supplemental opinion by the circuit judge* [author's italics]

"Upon the record before us a new trial should have been granted The judgment is reversed and a new trial granted with costs to the defendant"

The case was set for the second trial about a year later, and I was notified to hold myself in readiness for it In correspondence with one of defendant's attorneys, I wrote " I am going to make bold to tell you a few things about this case as I see them and if you find that you want to use them I will be glad to discuss them with you more at length

"First, the reaction produced by over

assist in an operation for its removal Defendant claimed the foot was exposed to the x-rays but a few seconds at a time and altogether above five minutes, and that, while the plaintiff was in his operating room about two hours and a half, he was performing an operation on the foot to remove the needle, and did not require and did not use the x-rays, except as above stated

"It is strenuously insisted, in behalf of defendant, that plaintiff's testimony relative to the time his foot was exposed to the rays should not have carried that question to the jury, because it was a physical impossibility for the plaintiff to have knowledge of or on the subject The credit to be given the testimony of plaintiff relative to the time his foot was exposed to the rays rested with the jury and we may not hold it of probative value

Defendant moved for a new trial alleging, among other grounds, error by the trial judge in making the following statement in the presence of the jury during the argument of counsel for defendant

"'Mr Cady, that is gross error You had no right to use such an argument to the jury, and if the jury render a verdict for the defendant in this case, I will set aside the verdict'

"The court stenographer was not present and the motion, in this particular, was supported by the affidavit of Mr L M F, one of defendant's attorneys No counter-affidavit was filed The trial judge denied the motion and filed written reasons but made no mention of this subject Defendant excepted to the denial and has brought the question here by assignment of error Such assignment of error, of course, accompanied notice of settlement of the bill of exceptions and was before the trial judge when he signed the bill The motion for a new trial, the assignment of error, and the brief of counsel for defendant all challenged the attention of counsel for plaintiff to this matter, and counsel for plaintiff, in his brief, took the position that the defendant cannot urge the point because his counsel did not object to the

remark of the court We need but say that counsel was not required to make an objection If the remarks were made by the judge, counsel was in no position to act in the capacity of a moderator and was not required to challenge the propriety thereof by objection An exception, under the present practice, could be claimed At the argument in this court, the serious character of the claimed error was indicated and later counsel for plaintiff brought the matter to the attention of the circuit judge, who then filed in the circuit court, a supplemental opinion or reasons for denying a new trial, and plaintiff, by motion, asks that the record be amended by inclusion thereof The case was argued and submitted in this court Oct 5, 1927, and then taken under consideration The supplemental opinion in the circuit court was filed Oct 22, 1927, eleven months after denial of a new trial In the supplemental opinion the circuit judge states that

"'As I recall the situation, the affidavit of Mr F is not in strict accord with the facts Mr C in his argument to the jury did use substantially the language as set forth in the affidavit of Mr F At that time the stenographer was not in the court room, and no record was being taken of the argument As soon as Mr C had made the statement in question, Mr G attorney for the plaintiff, objected to the statement The court thereupon told Mr C that in his judgment the argument was error and prejudicial, and that, should the defendant obtain a verdict from the jury, the court might be called upon to set the same aside because of such prejudicial argument

"'When the court stenographer was called he took the following

"'Mr G Counsel for the plaintiff strenuously objects to the statement of counsel for the defendant that the witnesses from Ann Arbor in this case were brought to this court by reason of influence of relatives of either the plaintiff's counsel or relatives

"'Mr C I did not so state to the jury that I believed it was influence brought by the plaintiff's counsel or relatives

"'The Court Counsel for the defendant

be in the dark in order for the fluorescence to be visible

"There is absolutely no sensation or effect upon any of the five senses from the x-rays there is nothing to be felt, seen (with the unaided eye), tasted, heard, or smelled. The apparatus used by Dr D, which produces these mysterious rays makes a humming noise and these rays cause certain substances to act peculiarly, but it is the effect of the rays and *not* the rays themselves that we see. The x-ray-producing apparatus makes as much noise while it is running and not producing x-rays as it does when the x-rays are being put out by it

"Lying—The plaintiff deliberately lied when he said that he could see the needle in his foot. He may have seen the light from the filament of the tube, but even that was pointed away from him. If you want to bring that out, ask for an explanation of how and why the Doctor could see and why plaintiff could not see it."

The case was tried again, but Dr Hickey, Dr Warthin, or the surgeon who amputated the leg did not testify at the second

trial. Dr A W Crane, Dr M J Hubeny, and the writer were called as experts by the defense, all agreeing materially with my testimony in the first trial.

The jury, evidently out of sympathy and compassion which was very strongly played up by plaintiff's attorneys in this second trial, brought in a verdict for the plaintiff, and the case was finally settled.

Here was a case in which the injury, alleged to have been caused by the x-rays, occurred on the plantar surface of the foot, when all the radiation occurred on the dorsal surface of the foot, in which roentgenograms of the amputated member as well as of the other foot and leg showed arteriosclerosis ample to produce the dry gangrene that the pathologists found in the amputated member, yet with all that well presented to twelve men sitting as a jury, the physician who was trying to do his best to relieve plaintiff was found guilty of malpractice and had to pay.

This case is one example of why we as radiologists have to pay such high rates for our malpractice insurance.

(To be continued)

dosage of x-rays would not be and under any circumstances could not produce ulceration on the plantar surface of the foot, if the overdosage was applied to the dorsum of the foot. I tried to bring this out as well as I could at the time of the previous trial, but I think that further and more detailed questioning, along with the opportunity to show by diagrams with pencil and paper, will put this over to a jury in a clearer and much better way.

"Next, the report of Dr Warthin *is the best thing you have if you can bring it out. It absolutely fixes the reason why they amputated the leg. The man had a dry gangrene, the treatment for which is amputation. THAT IS THE ONLY TREATMENT FOR DRY GANGRENE.* They operated for dry gangrene produced by and directly due to arteriosclerosis of the Monckeberg type.

"This 'marked Monckeberg calcification of arteries'—quoting Dr Warthin's report of the pathological diagnosis—is a combination of fatty degeneration and calcification of the middle layers of the walls of the arteries. It usually occurs in the aged, but *it is not rare in the arteries of the feet, legs, and thighs in men over 40 years of age.* It is the so-called 'pipe-stem' or 'corduroy' artery, and is the type seen in practically all cases of dry gangrene, and is known not to be the result of x-rays.

"Further, from another aspect, the report of the pathological diagnosis says 'area of dry gangrene,' and *dry gangrene never is nor can it be a part of or the result of recent overdosage from x-rays.* I can get any number of competent experts to so testify.

"Still further, the last sentence in Dr Warthin's pathological report stating that 'no active process,' shows that whatever pathology was present was of long standing, whereas any effect of overdosage of x-rays administered within the time shown by Dr D's records, and those of the case *would be active.*"

Upon request for items to be brought out by the expert roentgenologist's testimony, I prepared the following:

"Burn could not result from the amount of x-rays used, according to the records of the defendant. Neither could it result from that amount of x-rays plus the action of ichthyol or such other solutions or materials used in the dressing of the foot after Dr D's operation.

"Note. It may be well to steer clear of this, but if plaintiff's attorney brings out anything regarding dressing materials, I am prepared to testify that that combination would *not* produce a dermatitis, and my associate here will do likewise.

"Burns will not result from four times the amount of x-rays the defendant said he used—if the wall of the tube was 14 inches away from the skin and target or anode consequently 17 inches from the skin as the tube used is $7\frac{1}{4}$ inches in diameter and the focal spot of the tube is in the center.

"Under the conditions testified to by the defendant, a slight erythema—similar to a sunburn and no more severe—*might* result on the top or dorsum of the foot (the part nearest the tube) if four times the amount defendant claims to have used, was applied. However, it may be well to keep clear of this unless it is brought out by the other side.

"Burns could not be produced on the plantar surface of the foot (the sole) when the x-rays were applied to the dorsum of the foot only. *This is most important.*

"No x-rays are being produced in the Coolidge x-ray tube when the filament or hot cathode is lighted. In other words, the filament or hot cathode of the Coolidge x-ray tube does not of itself produce x-rays. A high tension current *must also be passed through the tube at the same time. This is most important.* If you want this brought out, ask us to explain it, at the same time handing witness the tube.

"The Coolidge x-ray tube looks exactly the same to a lay person, whether there are x-rays being produced or not, *while the filament is lighted.* The x-rays are invisible to the naked eye. Some substance that will fluoresce must be used to determine whether any x-rays are being sent out by the tube. The eyes of the observer must

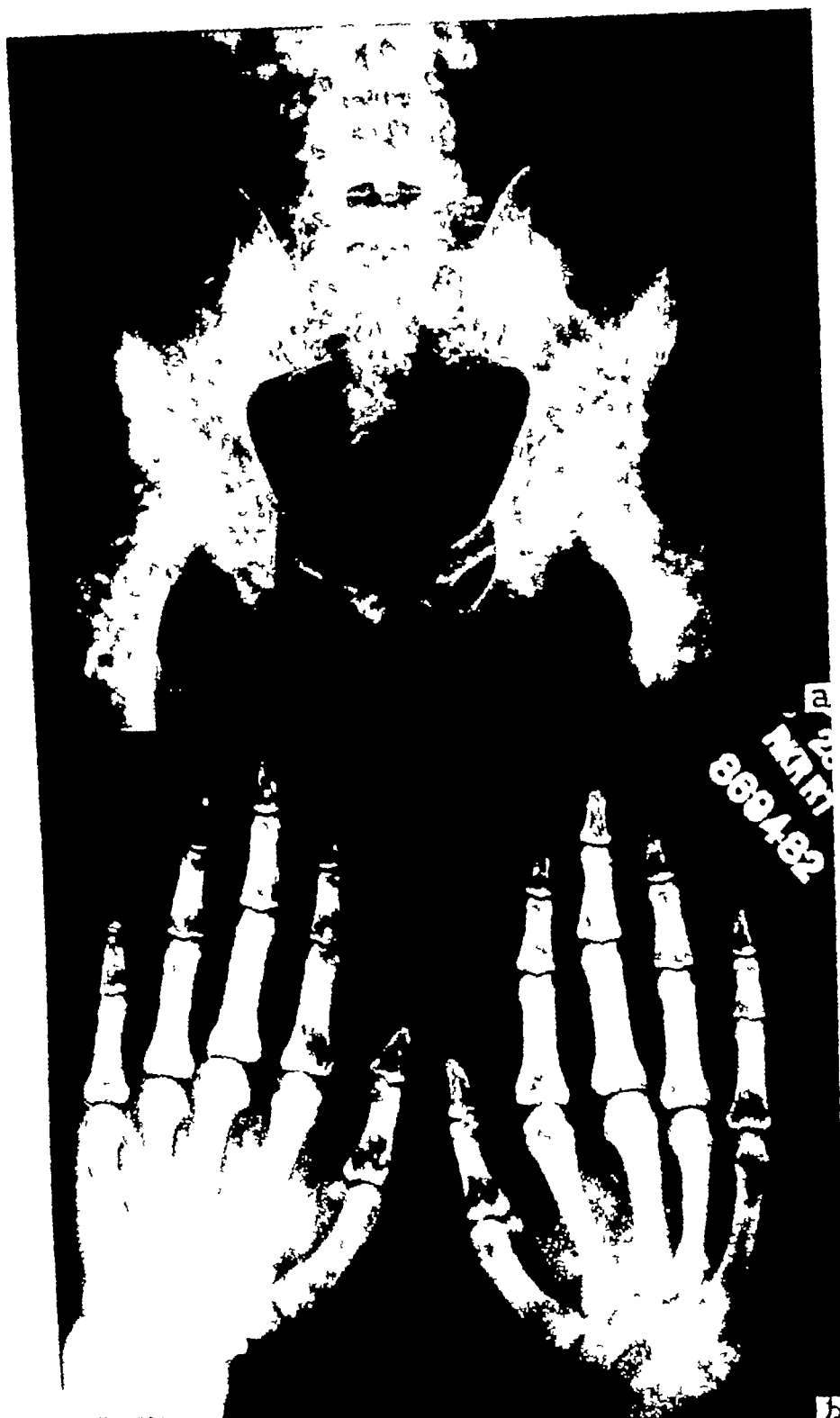



Fig 1 *A* (*above*) Osteopoikilosis involving the sacrum, the lower portions of the iliac, ischiatic and pubic bones, and the head, neck, and shafts of both femurs.

Fig 1 *B* (*below*) Osteopoikilosis showing discrete markings in bones of the hands. Compare these markings with the rather irregular spotting in the bones of the pelvis and in

OSTEOPOIKILOSIS¹

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 OSTEOPOIKILOSIS is a comparatively rare disorder which is generally conceded to be an anomaly of the skeletal structure that, because it is usually asymptomatic, is discovered most frequently by accident in the course of roentgenographic examination for evidence of, or for the cause of, other lesions. Albers-Schonberg first described osteopoikilosis in 1915.

A man, 21 years of age, came to him for examination because of various pains in one of his shoulders and one of his feet. He had acquired the condition during several months of trying service in the trenches. In civil life he had been an "enamel-burner" and, except for the symptoms just mentioned, he was in good health. Roentgenographic examination elicited, in all parts of the skeleton but the skull, clavicles, scapulae, spinal column, and patellae, and almost exclusively in the spongy substance, a peculiar structure consisting of round or oblong, but generally rather closely clustered dense spots that gave the bone a characteristic speckled appearance. These spots varied in size from 2 to 5 cm. in length, and the higher they were situated in the metaphyses the larger and longer they were. They appeared even in the corticalis, but without elevation of the surface. In the small bones of the hands and feet, and especially in the heads of the metacarpal bones, the shape was chiefly round. All the spots were clearly defined. A few of them were not quite compact but, as was the case in a phalanx of the thumb, were ring-shaped, with a lighter center. The longitudinal axis of the spots invariably agreed with the longitudinal axis of the skeletal parts in question, and in the short bones the structures of the bone shafts were generally followed with fair distinctness.

Ledoux-Lebard, Chabaniere, and Dessane reported a similar case in 1916, and because of the spotted appearance of the bones they gave it the name "osteopoeclia."

Some thirty-two cases have been reported in the literature, and in these involvement has been noted in the clavicle, scapula, patella, and spinal column, the spottings were less numerous, however, in these bony parts, and they have been in the accessory processes of the vertebrae and not in the bodies. Mascherpa stated that Bisolfi, in 1927, presented the case of a person 21 years of age in which nodules were found in the occipital bone. Other than this no lesions have been reported involving the skull.

In August, 1934, an American-born Jew, aged 26 years, came to the Clinic with an indeterminate abdominal lesion and an excessive flatulence which had been present for ten years. This flatulence had been aggravated following an abdominal operation elsewhere four months previously. During routine examination, the patient mentioned that roentgenograms made elsewhere had exhibited some abnormality of the skeletal structure. The patient also stated that an only brother had a similar abnormality of the skeletal structure on similar examination elsewhere.²

Roentgenographic examination at the clinic revealed diffuse mottling of the bone of the acetabulum, pubis, and ischium, with a few scattered spots running into the outer third of the ilium on both sides (Figs 1-A and 1-B). This diffuse mottling also involved the neck and head of the femur on both sides and the shafts of the femur to about 5 cm. below the intertrochanteric line. General examination of the skeleton showed spotting of the bone in the epiphysis of the humerus, radius, and ulna,

¹ Read before the meeting of the Minnesota Radiological Society, Rochester, Minn., Oct. 13, 1934. Submitted for publication May 17, 1935.

Since this was written word has been received from Dr. John W. Riley of Tulsa, Oklahoma, that the mother of the patient showed bone changes similar to those exhibited in the brother.

about ten centimeters along the diaphyses. These striæ were broad, averaging 5 mm in width. Similar involvement was noted in the metacarpals and the metatarsals, with only occasional involvement of the diaphyses, when this did occur it tended toward a linear

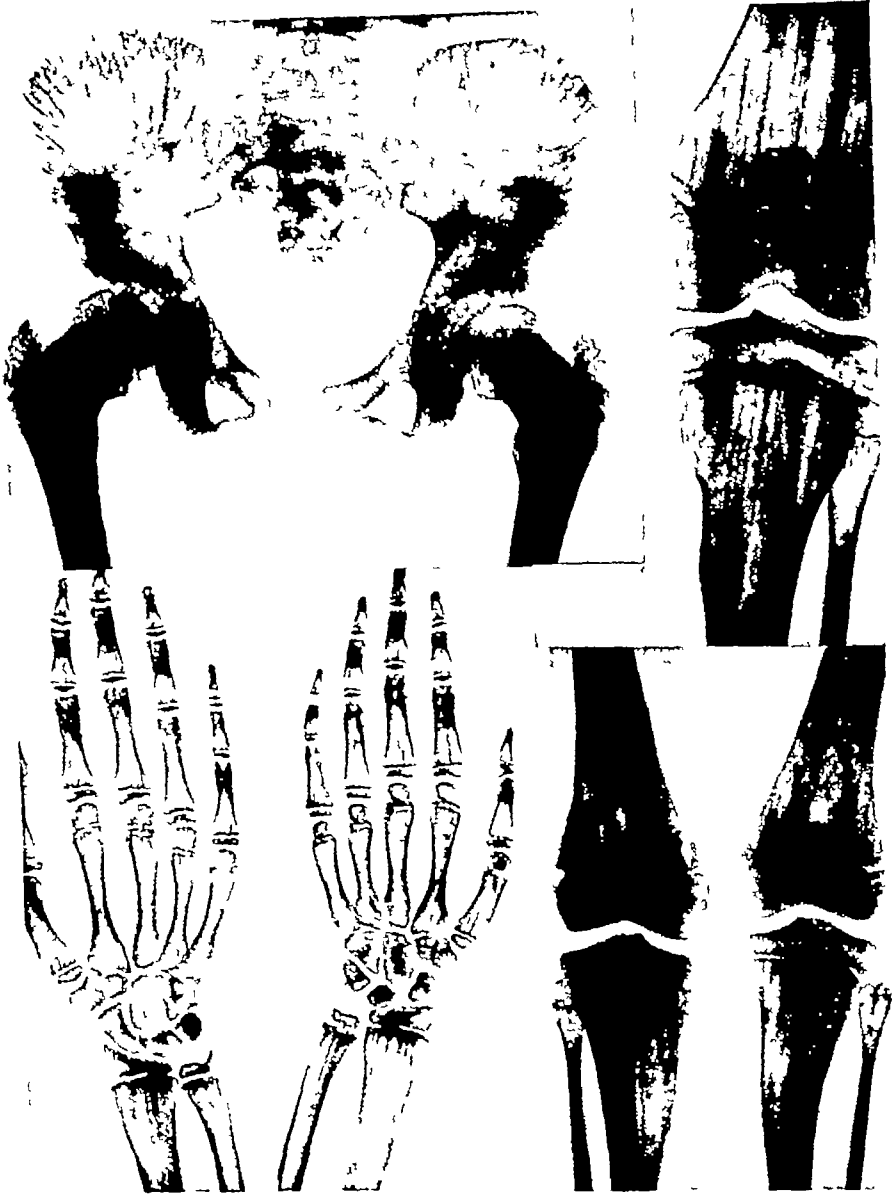
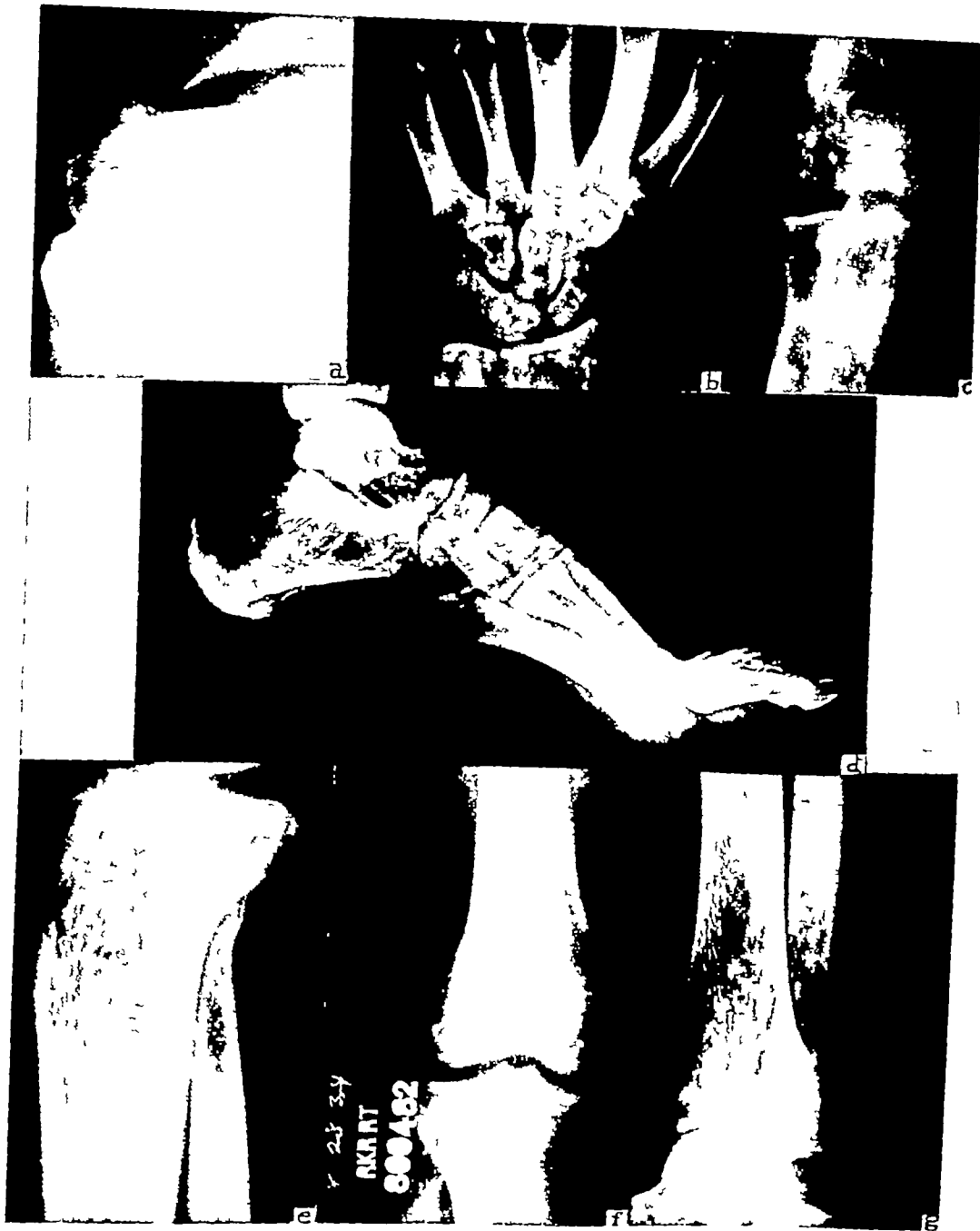


Fig. 3. Osteopoikilosis. Roentgenograms from case reported by Voorhoeve (*Acta Radiologica* 1924 3, 407. Reproduced by courtesy of that Journal.)

the lower portion of the tibia, and there were striæ extending into the diaphyses of both the tibia and fibula. The distribution of the discrete mottling seen in the bones of the feet was very similar to that in the hands; the spotting was largely limited to the epiphyseal portions of the metacar-

striation. There was a discrete mottling throughout the bones in the carpus and tarsus (Figs 2-A to 2-G). There was no definite evidence of involvement of the bodies of the lumbar vertebrae, but there were a few scattered spots in the spinous processes. The skull did not reveal any changes in bone



Figs 2 A-2 G Osteopetrolisis of epiphyses and extending to diaphyses Note the discrete mottling of epiphyses and tendency to striation as lesion extends to diaphyses

at both extremities, in all the carpal bones, and in the extremities of the metacarpal bones and phalanges. The acromion process of the scapula revealed similar spotting. The lower ends of the femurs were mottled with discrete rounded shadows in

the epiphyses and linear shadows extending approximately 10 cm into the diaphyses. The spotting was confined to the head of the fibula on both sides, but in the tibia a discrete mottling involved the epiphyses and there were linear striations extending

roentgenologically and found to be free from any abnormalities in the bone. In the case reported in the present paper, an only brother presented evidence of involvement of bone similar to that seen in the patient.

There have been many suggestions regarding the etiology of osteopoikilosis. Schinz, Baensch, and Friedl were of the opinion that it is a maldevelopment, and probably arises by a mutation and occurs recessively; they pointed out in a diagram the symmetrical distribution of the lesions. Sváb considered heredity important and thought that diabetes exerted an aggravating influence in his cases. He quoted Buschke and Ollendorf as having pointed out analogies between disseminated lenticular dermatofibrosis and osteopocilia. Wachtel suggested that the condensations corresponded in their situations to emboli of the terminal arteries. Tuberculosis has been considered to be only a coincident occurrence in some of the cases and not an etiologic factor. Greig has asserted that calcification is a passive process and occurs in feebly vascularized structures; the blood calcium is maintained within narrow limits of the normal, apparently by the action of the normal parathyroid glands, and any extra calcium is not met by the depletion of the blood calcium but by extraction from the great store of calcium available throughout the skeleton. Conversely, however, should the calcium content of the blood serum be high, it is conceivable that general calcinosis may result, and some dysfunction of the parathyroid glands may then be suspected. Calcification is not a primary manifestation and, when discovered, is evidence that the structure in which it occurs has undergone functional deterioration and is out of action, at least to some extent. His observation that if the blood supply to a bone is decreased the bone undergoes increased calcification is in agreement with observations of Schinz, Baensch, and Friedl, and Wachtel as to the probable mechanism of deposition of calcium in this lesion. The definition of the etiology is probably a physicochemical problem.

The roentgenograms in the case reported

by Nichols and Shiflett, by the unusual features which they presented, bring another type of unexplained developmental anomaly into the discussion. Léri and Joanny, in 1922, reported a lesion of bone of which they had been unable to find another example in the literature. Roentgenographically, certain aspects of all the long bones in one extremity revealed thickening and irregularity of the contour shadow due to a mass of compact, dense bone "smeared" over them in a manner suggesting a flow of some viscid material along one border of the bone. The involvement did not correspond to any peripheral nerve distribution, nor did it appear to have any relation to the vascular distribution. They gave this lesion the name "melorrheostosis," which they considered indicated the essential clinical characteristic hyperostoses, from "*melos*" meaning *a member* and "*rhoea*" *to flow* (Fig 4). Lewin and MacLeod, in 1925, reported a similar lesion, and invited suggestions as to its nature (Fig 5). The family history in this case was negative, no other members of the family having any defects of bone, although a grandfather had predicted that the patient would have trouble with the bones of his right forearm and hand until he reached the age of 30 years; this was the only suggestion of an hereditary factor. Junghaven found five cases described in the literature up to 1930; he had followed one case roentgenologically and clinically, and studied material obtained when osteotomy was done. He found a sclerotic or eburnating degeneration of the bone, and, because it had been in all reported cases monomeric (localized to one extremity), he suggested the name "monomeric eburnous osteosis." The osseous change begins in early age and, clinically, results in an increased volume of the limb, with secondary deforming arthritic changes due partly to hyperostotic developments along their cortical envelope, and partly to displacements resulting from these. He was inclined to consider it as an anomaly. Kahlstorf tabulated 10 cases, in 1930, which he had found in a review of all cases in the world literature. He stated

Roentgenologic investigation of the thorax and gastro-intestinal tract did not reveal any abnormalities. Urinalysis, blood count, and morphologic examination of blood smears and serologic tests for syphilis all proved negative. The patient had no clinical symptoms referable to this condition of the bones other than a dull ache on cool days, usually in the legs. A large keloid had developed in the abdominal scar from the former operation. Hematologic determinations revealed calcium, phosphorus, phosphatase, and the albumin-globulin ratio to be within normal limits.

Voorhoeve, in 1924 (Fig. 3), found a strikingly different type of lesion in the case of a boy, aged 14 years, while making a roentgenographic examination to elicit the cause of a chronic synovitis in a knee joint. Dark, vertical, and very pronounced rays were revealed, giving shadows much stronger than those of normal bone. In portions of the femur, tibia, and fibula contiguous to the articulation, they ran almost parallel to the long axis of the bone, commencing at the epiphyseal line they were prolonged into the diaphyses, some of them for a distance of 8 cm., and similar rays were seen in the pelvic bones, wings of the sacrum, calcanei, scapulæ, and ribs near the costochondral articulations. The direction of the rays was found everywhere to be the same as that of the architecture of the spongiosa. The iliac bones, femoral neck, and calcanei clearly showed this arrangement. Roentgenographic examination showed that this boy's sister had the same skeletal affection, even greater in some areas than that of her brother. The father also gave evidence of alterations in structure which were similar to those of the children but to a much less degree. Nothing abnormal was found in the skeletal structure of the mother. Voorhoeve found clear spots where, sometimes, the ordinary structure of the bone was no longer visible (giving the impression of vacuoles), and small exostoses in very large numbers which were somewhat similar to those seen in multiple congenital exostoses. He also found points of osseous condensation in the phalanges of the hands and in

the carpal bones. Re-examination of the children one year later did not show any changes of note. He suggested that chondrodysplasia (multiple congenital exostoses) and osteopoikilosis (*osteitis condensans disseminata*) might be two manifestations and phases of the same process.

Newcomet reported the first case of osteopoikilosis in the American literature, in 1929, under the name of "spotted bone." He had examined his patient after a four-year period and found no alteration in the character or extent of the lesion. Schmorl, in 1931, reported the first study of the condition at necropsy and stated that "No deductions can be made from the microscopic findings concerning the genesis of this disease. An endochondral origin can be eliminated on the basis that the foci show no connection with the endochondral zone of growth. The most plausible theory is that of a congenital anlage."

The hereditary phase of osteopoikilosis is not discussed in the greater number of articles available for review, but, as before mentioned, Voorhoeve found evidences of involvement in the father and a sister of his patient. Awalischwili's patient was one of a peasant family of eight brothers and two sisters, and none apparently were found to be involved. The two patients whose cases were reported by Wilcox (23 and 24), in 1932 and 1933, were of one family, the son having more extensive involvement than the father. A sister had marked hypertrophy of the inner and outer tables of the skull, the two tables being completely fused. The process involved the skull on the right side, from near the vertex posteriorly to the level of the supra-orbital plates, the hypertrophy extending into the sphenoidal sinus. The mother thought the deformity, which had been known since the girl was five years of age, was a residual of injury from forceps delivery of the child. Sváb reported three cases occurring in one family, a father and two sons, and just as has been noted in other cases the lesions were less widely distributed in the father. The mother of these two sons and a small daughter of the younger son were examined



Fig 5 Melorheostosis. The roentgenograms were sent to various consultants some years ago and none had seen a similar lesion. The suggestions were that it was some type of neurotrophic disorder. (Case reported by Lewin and MacLeod. Reproduced by courtesy of *Journal of Bone and Joint Surgery*.)

that it had not been possible to determine the etiology and pathogenesis. The process apparently arises within the bone and has an extremely slow progress toward the surface, and only on involving the periosteum and joint surface does it give rise to subjective joint symptoms. He considered that this rare disease of bone was a disease *sui generis*, distinguishable from all other known diseases of bone, either generalized or localized, and attacking only bones of single extremities in segmented stripes. Progress is in a more or less straight line. He quoted Putti as regarding vascular changes as the primary cause, the vascular changes themselves being primary sclerosis with its origin in the sympathetic nerve. He pointed out, however, that the distribution of the process did not coincide with that of the sympathetic innervation. Poliard, he stated, regarded narrowing of the vascular lumen as secondary. The discovery of further cases in which the distribution disagreed with the distribution of peripheral nerves led him to doubt Lewin and MacLeod's belief that the bone affection was related to a lesion of the periph-

eral nerve of the corresponding spinal ganglion. Léri and Lièvre's suggestion of a parasitic infection, from the striped arrangement and partial involvement, leading to continuing broadening and slow tendency to progression and generalization has not definitely been proved. Zimmer's assertion that a disturbance of development, in the lack of an anlage in a segment of the attacked extremity, would well explain the striped arrangement because only one segment is laid down defectively. The illustrations of Nichols and Shiflett present, along with the characteristic lesions of osteopoiikilosis, involvement of the bone shafts which at first glance strongly suggests melorheostosis. However, on referring to the illustration in which they have assembled the roentgenograms, one finds that the distribution involves both upper and lower extremities, and is, in a manner, bilaterally symmetrically distributed. Study of the individual extremities indicates a lack of continuity of the shadow along the bone observed in melorheostosis, and examination of the individual bone shows bilateral increased density and thick-



Fig 4 Melorheostosis This was one of the earliest cases seen on this continent and was not published at that time because the condition had not been recognized (Courtesy of W G Hermann M D Asbury Park N J)

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(25) ZIMMER, P Über einen Fall einer eigenartigen
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75-85

ening of the cortical shadows, all of which would seem to rule out melorrrheostosis as a coincident lesion. It is of interest that their patient clinically gave evidence of endocrine dysfunction.

A review of the subject of multiple cartilaginous exostoses (chondrodysplasia) on which some 400 articles have appeared in the literature, dealing with more than 700 cases, reveals that this lesion has been observed in different forms and described under various names according to the theories advanced as to its nature and etiology. It presents features in common with osteopoikilosis, to which it has been linked by the findings of Voorhoeve. It is hereditary and familial, and affects both males and females, the former more frequently than the latter. It apparently may be transmitted by an unaffected female. Both are evidently diseases of the period of skeletal growth, are first noted in infancy or in early childhood, increase with skeletal growth, and cease to develop about the time of skeletal maturity. The most probable hypothesis as to etiology is given as a disturbance in development of the intermediary cartilage due to an original defective anlage, the lack of an anlage in the involved extremity is the most generally accepted theory of the etiology of melorrrheostosis.

Roentgenographically, chondrodysplasia appears to be an entirely different type of lesion from osteopoikilosis and melorrrheostosis. In the last two the evidence suggests a diminution or cutting off of the blood supply, either primary or secondary, whereas in the first the evidence strongly supports the theory of Keith that a defect in the periosteum removes the restricting influence that it exerts in the proper shaping of the bone.

Chondrodysplasia and osteopoikilosis are hereditary and familial; there was only one suggestion that I could find of the hereditary factor in melorrrheostosis. The cases reported by Voorhoeve and by Nichols and Shiflett are of particular interest, because the former lack entirely the spotting which gave the condition its name, and the latter

present areas of typical spotting of osteopoikilosis and massive, irregular eburnation of the bone shafts distributed in a manner entirely different from that of the other reported cases of melorrrheostosis.

With the extensive experimental investigation now under way to determine the part played by the endocrine glands in disorders of bone, we may have some additional information supplied that will assist in classifying more accurately these comparatively rare lesions. In the meantime it is imperative that all similar lesions be reported in order that such cases may be made available for study and comparison.

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The present-day routine roentgenographic examination of the shoulder girdle is still limited to one exposure in the antero-posterior direction. The so-called "axial exposure" is employed only in isolated cases, and in my experience is not the standard one in many hospitals. As a rule, the examination of the shoulder girdle in two planes at right-angles to each other is dispensed with, and the diagnosis is based on one view only. Without exposures in two directions, the diagnosis of injuries and diseases of the shoulder joint, of the clavicle and the upper third of the humerus, would be as incomplete as that of the extremities and the vertebral column. It is in the shoulder girdle that numerous lesions occur which play an important part in surgery, but which may escape correct interpretation unless lateral films are taken. I need only mention the oblique longitudinal fractures of the acromion, fractures of the capital and subcapital end of the humerus, and the arthritic changes of the acromio-clavicular joint. Particularly fractures of the upper end of the humerus, with or without dislocation of the shoulder joint, require axial exposure, since by this technic alone can the true position of the fragments be judged. Technical difficulties in taking the axial view are undoubtedly the only reason why x-ray examination of the shoulder girdle in two planes has not yet been adopted as a routine.

The customary anteroposterior exposure of the shoulder joint may, of course, be most usefully supplemented by a postero-anterior exposure, though the applicability of the latter is so limited that it does not deserve being standardized as "typical second plane."

The same, in my opinion, is true of the stereoscopic view of this region. Like Boehler, I must emphasize the inadequacy of a stereoscopic exposure in a single plane. One must take either stereoscopic exposures in two planes at right-angles to each other, or stereoscopic views must be used only for supplementing the two-direction exposure.



Fig 4

For many years I have endeavored to elaborate an exact technic for the lateral or axial shoulder view. After several experiments, I finally have obtained satisfactory exposures by using a simple apparatus, which enables one to take standardized axial views in every shoulder case.

The exposure is made with the patient sitting on a stool, employing a shockproof tube, which, at about the height of the seat, can be approximated to the patient's body without danger (Fig 1). The direction of the rays is vertically upward. The arm is abducted horizontally, whereby the patient's hand finds support on the upright of the tube stand. The position of the cassette is very important. The cassette is cut out at one end, so as to fit around the neck to bring the plate near enough to the mid-line of the body. For this purpose a cassette holder is required which is attached and moves easily on a light pedestal. This special cassette can be fixed at any desired point of the frame. A metal rim prevents the cassette from slipping and carries two movable screw clamps to press it against the patient.

NEW TECHNIC FOR THE ROENTGEN EXAMINATION OF THE SHOULDER JOINT

By H. JORDAN, M.D., *New York City*

THE bones of the shoulder girdle are so superficial and anatomically so characteristic that their clinical examination is quite easy. It is, therefore, all the more surprising that they should cause difficulty in roentgen examination, conditioned mainly by the attachment of the shoulder girdle to the trunk, and by the relative position of the individual bones in an anteroposterior direction.

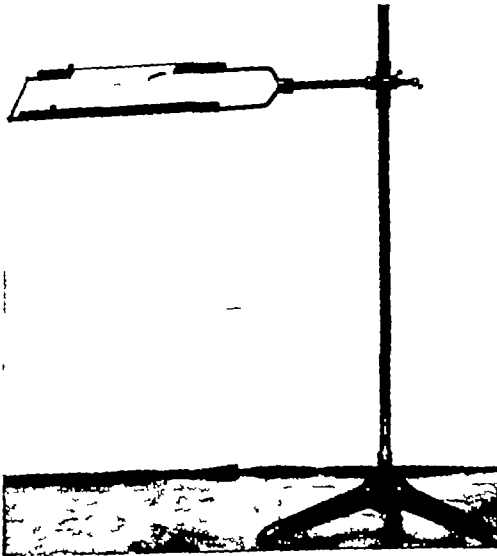


Fig 1

As a result, in the roentgenogram, part of the shoulder girdle will be nearer to, and part farther from, the film and nearer to the focal point of the tube. Furthermore, the barrel-shaped structure of the trunk with its individual variations interferes with the typical position of the patient, and may even render exact comparative exposures of both shoulders in the same patient difficult if not impossible.

The roentgenogram also gives a two-dimensional shadow of a three-dimensional body. Hence, the so-called projection plays a decisive and at times embarrassing part. Interpretation of the shadow is complicated by the fact that the projection is affected by the shifting of the X-ray beam, and by changes in the position of the object if the position of the film is considered fixed. Naturally, these changes are utilized in order to obtain more information in difficult cases.

"Deceptive projection" and other errors may be avoided by taking typical, standardized roentgenograms of the shoulder girdle in two planes at right-angles to each other. This may be done as easily and as readily as carrying out the routine in making X-ray exposures of the extremities and the spine.

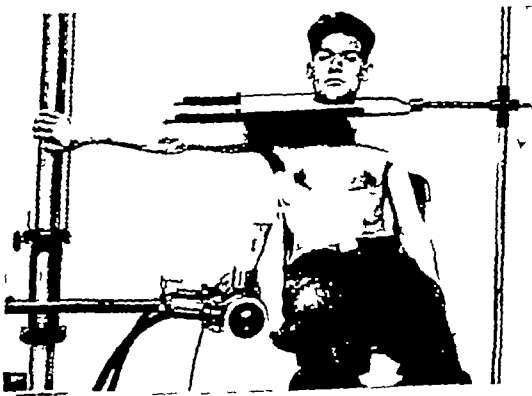


Fig 2

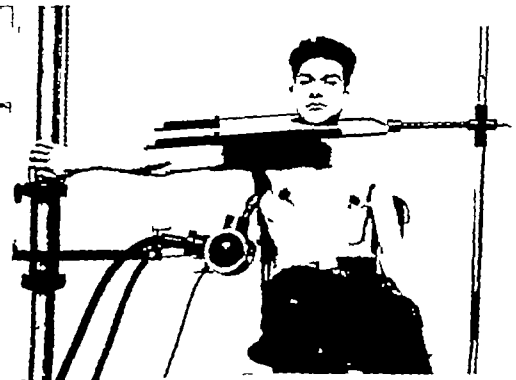


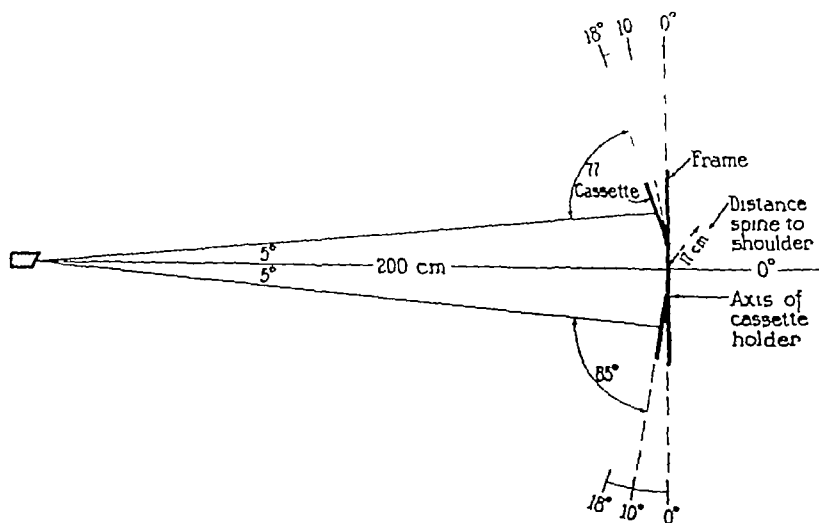
Fig 3

tive pictures of both shoulder joints under exactly the same radiographical conditions

The barrel-shaped structure of the trunk and the attachment of the shoulder girdle to it make it practically impossible to obtain strictly comparable films of both shoulders with the patient lying on his back. In the prone position, the shoulder joint is far away from the table, and, therefore, we tilt the patient, as a rule, on the respective side, in order to bring the joint proper as near to the film as possible and to avoid distortion. However, even by tilting the patient on his side, one frequently has to bring the film closer to the patient by means of sand bags, etc., features which are extremely difficult to measure or judge, and which, therefore, cannot be reproduced for the



Fig 9



Scale 1 10

Fig 10

comparative x-ray with constant exactness. This is all the more true if we are dealing with a marked kyphosis or even a very obese patient.

To avoid these difficulties, I have designed a new device which permits the taking of comparative x-rays of both shoulder joints of a patient

without distortion, under identical conditions, with one exposure or, without moving the patient, in two exposures (Fig 7).

In a metal frame, two cassette holders are fixed in such a manner that they can be moved horizontally, in order to adjust the cassettes to the distance of the



Fig 5



Fig 6



Fig 7



Fig 8

After seating the patient in the prescribed manner and centering the tube, the cassette holder is pushed over the patient's shoulder girdle from the unaffected side, and the special cassette is adjusted so as to lie just above the shoulder without being supported by it (Figs 2 and 3). It is important that the cassette should not touch the shoulder, but should be carried solely by the holder. During exposure the patient is told to hold his breath. This fixation has proved quite sufficient with the average exposure of a few seconds. There is no blurring. The use of this exposure technic is only impossible if the arm is fixed to the trunk or if it cannot be abducted at least 75 degrees. In such a case the patient has to be placed

in the lateral sitting position, and a picture is obtained by aiming frontally through the thorax (Fig 4). In recent injuries I always think it advisable to use local anesthesia before the roentgen examination, and to reduce the fracture, etc., immediately afterward. This method is to be specially recommended for fractures of the head, of the humerus, and of the acromial end of the clavicle.

The method described makes radiographs of the shoulder joint in two planes so easy that there is no objection to using this technic as a routine (Figs 5 and 6).

Owing to the anatomic peculiarities mentioned at the beginning of the paper, it is somewhat difficult to take compara-

FLAT FOOT

A CONSIDERATION OF THE ANATOMY AND PHYSIOLOGY OF THE NORMAL FOOT,
THE PATHOLOGY AND MECHANISM OF FLAT FOOT, WITH THE RESULTING
ROENTGEN MANIFESTATIONS

By MORRIS KAPLAN, M D, Assistant in Roentgenology, New York Post-graduate Hospital,
Roentgenologist New York Police Department, and THEODORE KAPLAN, M D,
New York City

THE condition of flat foot is of such prevalence as to render proper diagnosis, as a prelude to treatment, of first importance. In this paper, the writers, in the hope that it may be of interest and value, submit for consideration the roentgen findings.

As an aid to diagnosis and adequate interpretation of the radiographs, a brief recapitulation is perhaps desirable of the anatomy and physiology of the foot as affecting—and resulting in—the condition of flat foot.

Definition and Classification—The term "flat foot," when properly defined, should be restricted to those cases in which the arch of the foot either touches the ground or in which it is so much lowered that it nearly touches. The diagnosis of this condition is determined by the fixed reduction or obliteration of the dome of the foot.

Classification may be made as follows:

1 *Spasmodic* Oncoming, to be corrected by manipulation.

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Anatomy—The foot is triangular in form, broad across the toes and narrow at the heel. Normally the foot is an arch supported on three piers, posteriorly by the tubercle of the os calcis and anteriorly by the heads of the first and fifth metatarsal bones. The summit of the arch is the

superior articular surface of the astragalus. The anterior posterior arch is composed of posterior and anterior limbs, the former measuring approximately three inches in length, and consisting of the os calcis and the posterior part of the astragalus, while the latter measures some seven inches, and is made up of the rest of the tarsals and metatarsals. Also, the anterior limb is divided into two parts, an inner segment, consisting of the head of the astragalus, scaphoid, cuneiform, and the inner three metatarsals, and an outer one, comprising the outer segment of the os calcis, cuboid, and outer two metatarsal bones. The hind part of the foot articulates in front with the forepart at the midtarsal joint, which is in two divisions, the inner, astragaloscaphoid, and the outer, os calcis cuboid.

The anteroposterior arch may also be divided into an inner and an outer arch, the inner arch including the os calcis, astragalus, scaphoid, three cuneiforms, and inner three metatarsals, the outer arch, much lower than the inner arch, made up of the calcis, cuboid, and outer two metatarsals. The highest point of the outer arch is between the cuboid and calcaneus. When weight is borne on the foot, the outer arch becomes obliterated and comes in contact with the ground.

The os calcis projects backward into what is called the tuberosity, which forms the projection of the heel.

The subastragaloid joint (astragalo-calcaneo-scaphoid articulation) is composed of the os calcis, astragalus, and scaphoid. The under surface of the joint is formed first by the surface of the scaphoid, next by the inferior calcaneo-scaphoid ligament, by the upper surface of the sustentaculum tali,

two cassette holders consist of small metal frames which are made to receive an 8×10 cassette. Each holder revolves around a vertical axis, their angle with the frame can be fixed at any desirable degree. The cassette holders of the right and left side have to be fixed at corresponding angles.

The large frame containing the cassette holders moves vertically on two pillars, and can be adjusted to the height of the patient.

The patient sits on a chair, the median plane of his body corresponding to the vertical mid-line of the frame (Fig. 9). The cassette holders are brought in the right position in vertical and horizontal directions, the distance of each cassette-center from the mid-line of the whole frame corresponds to the distance of the patient's shoulder joints from his spine. When the patient sits leaning with his back against the frame, the upper arms vertically downward, forearms resting in the desired position (as a rule, in the coronoid plane), and hands on the thighs, the one cassette is turned round the vertical axis of the cassette holder until it is as near to the body as possible. The other cassette is then fixed at the same angle.

For the majority of cases, one exposure suffices for taking comparative x-ray films of both shoulder joints. In order to eliminate undue distortion, especially in an obese patient in which case the part of the shoulder girdle is removed from the film, we take these views with a focus-film distance of two meters (6.5 feet). Though the center beam is not used in such a case, the deviation is so slight that

it can be neglected, all the more so as the angle between the cassette holder and the frontal plane in most cases does not exceed 10 degrees. The diagram shows that the angle of incidence is only plus/minus 5 degrees from a right-angle (Fig. 10). The exposure time was about 5 seconds by 35 ma and 54 kv.

For a separate exposure of each shoulder joint, the exposure is taken in the same manner by shifting the tube correspondingly to the left or right without moving the patient.

This arrangement is so simple that it is not difficult to study and compare both shoulder joints in every desirable degree of abduction, adduction, elevation, and internal and external rotation.

In suggesting the incorporation of the above two methods in the routine standardized technic, which is so important for the successful running of the x-ray department, I would conclude by emphasizing that it would nevertheless be a mistake to attempt any schematization. It is particularly in the roentgenology of the shoulder girdle that what I have called "search with x-rays" is at times indispensable. Here, the postero-anterior exposure and oblique views, shifting the tube, especially in the vertical direction upward and downward, is indicated, and, sometimes, a close-up with a film-focus distance of from 30 to 40 cm may give additional information.

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FLAT FOOT

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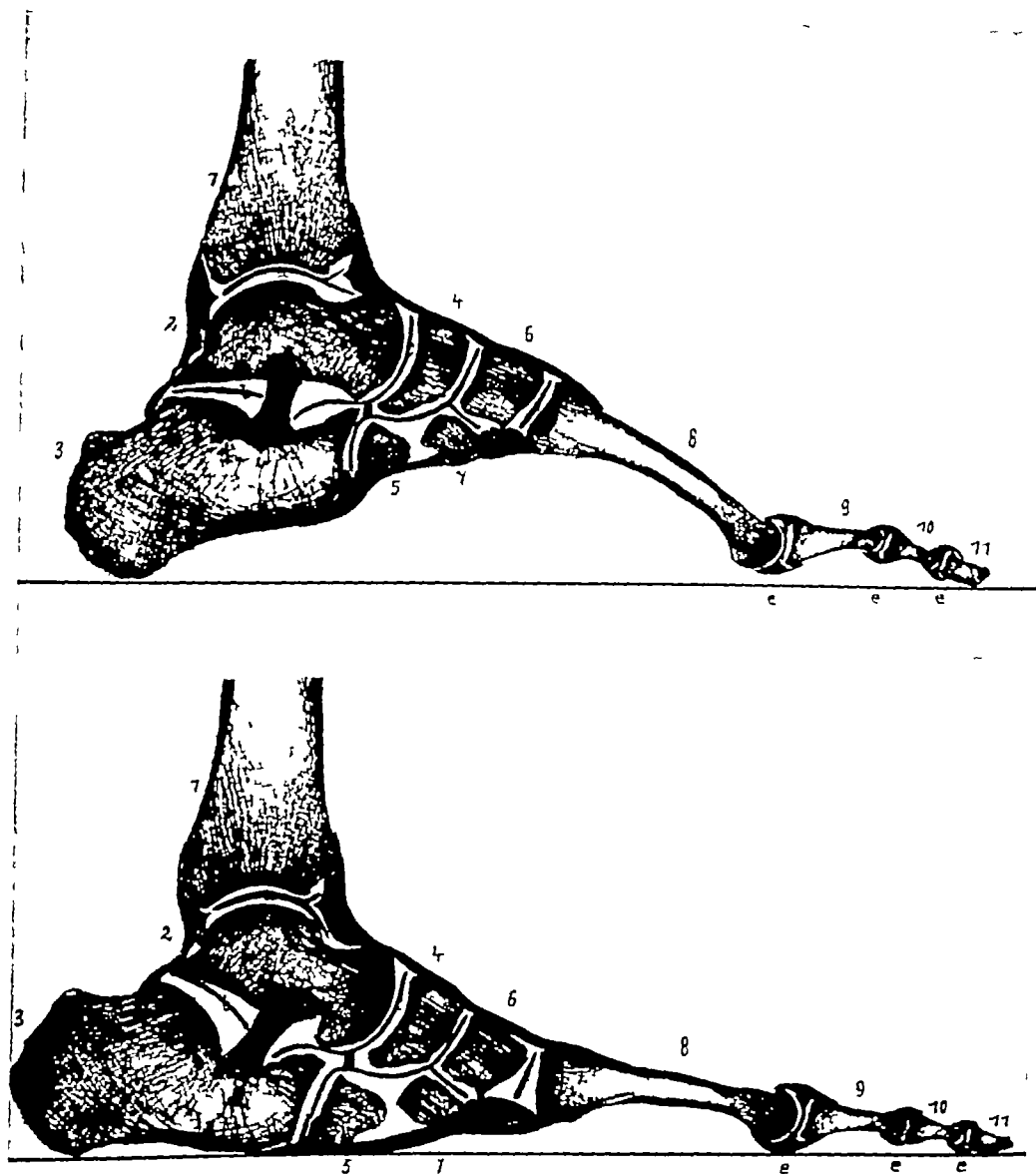


Fig 1 Microtome section of the leg and foot. The upper represents normal arch, the lower flattened arch. Key to numbered parts: (1) tibia, (2) astragalus, (3) os calcis, (4) scaphoid, (5) cuboid, (6) and (7) cuneiforms, (8) metatarsals, (9, 10, and 11) phalanges, (E) interphalangeal joint.

the interosseous ligament, and finally by the posterior surface of the os calcis. The inferior calcaneo-scapoid ligament is the most important one in maintaining the integrity of the arch. In addition, in order to provide against the luxation, the joint is strengthened by three ligaments, viz.,

- 1 The interosseous astragalo-calcaneal ligament, running obliquely forward and

outward between the calcaneum and astragalus.

- 2 Internal lateral ligament of the ankle (deltoid) which send fibers by its superior part to the sustentaculum tali and by its deep part from the tibia above to the side of the astragalus below and to the scaphoid in front.

- 3 External lateral ligament of the ankle,

anterior and posterior fasciculus, both attached to the astragalus, and the middle fasciculus goes to the calcaneum below

of the longitudinal arch is at the astragalo-scapoid articulation, which is braced by strong ligaments and muscles, of which the

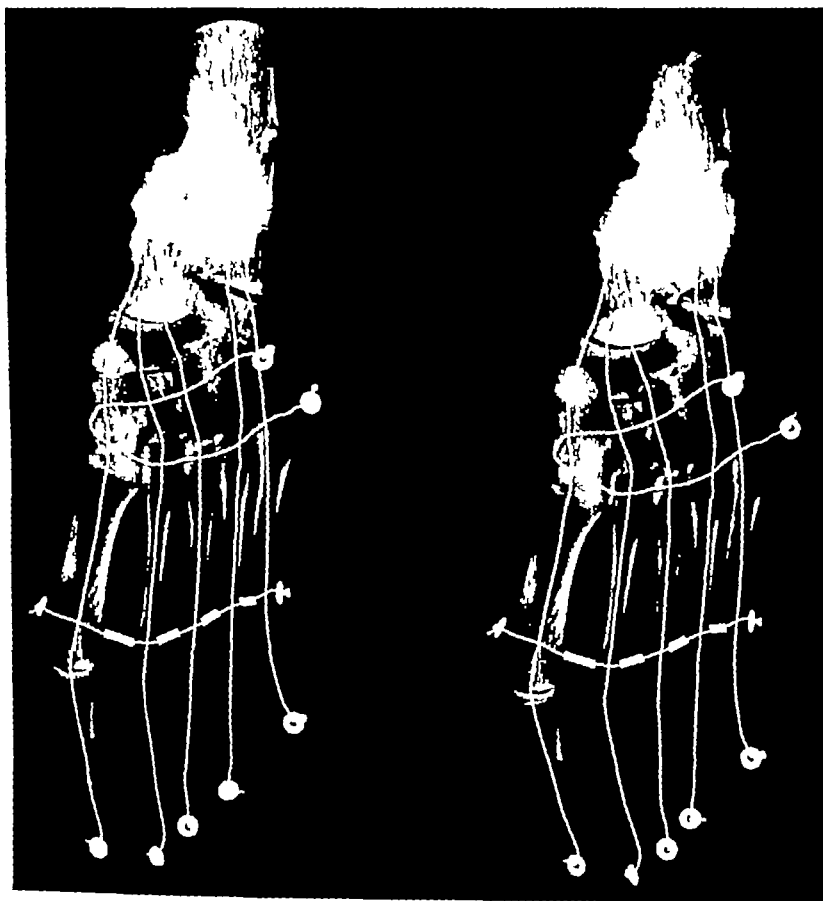


Fig 2 Dorso ventral views of the foot *Left* represents the skeleton of the foot resting *right* has been hyperflexed to give the arch position

The instep or arch of each foot forms a half-dome and when the two feet are close to each other they form a dome, not circular but elliptical in shape, extending around the edge from the heel of one foot, round the outer border of the foot along the tread, and back along the outer border of the other foot to the heel. Considering one foot by itself, the weight of the body rests upon a half-dome, touching the ground on its outer border. The foot is stable if the body weight is so balanced that it rests on its outer edge, but if the body weight falls too near the inner side of the half-dome, there is a tendency for it to capsize inward.

The highest point and the weakest part

more important is the inferior calcaneo-scapoid ligament.

The transverse arch extends across the foot from the heads of the metatarsals to the mid-tarsal region of the scaphoid. The outer end of the transverse arch is supported by the outer edge of the foot, which, through soft parts, is in contact with the ground. The inner end is supported by the inner edge of the foot, which is some distance above the ground. The anteroposterior and transverse arches are maintained not only by the ligaments but by the plantar fascia, interossei, short flexors, peronei (*longus*, *brevis* and *tertius*), tibiales *anticus*, and *posticus* muscles and to a certain

extent by the abductor pollicis and abductor minimi digiti

In talipes valgus the forefoot is abducted

the arch should be well without this line, and similarly, the front and outer border should be slightly convex

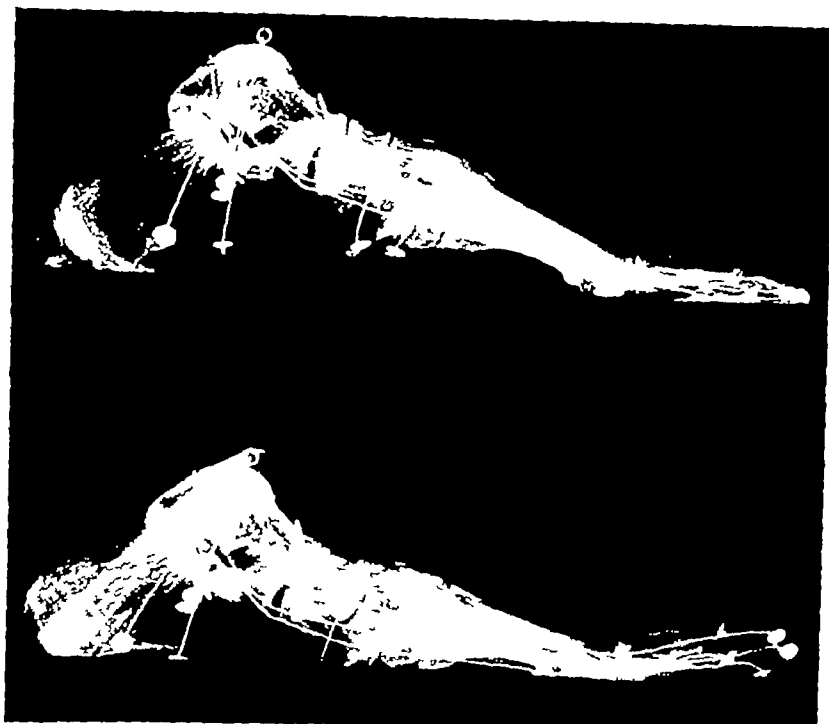


Fig 3 Lateral views of the skeleton of the foot the upper representing the normal arch and the lower after flattening of the foot

from over-action of the abductor minimi digiti, peroneus (longus and brevis), and is usually associated with pronation and eversion anteriorly. The angle of deflection is less than 25 degrees. The normal angle of deflection is produced by the intersection of a line from the center of the os calcis through the middle toe at the mediotarsal joint with a second line passing through the ball of the great toe, forming normally an angle of from 25 to 30 degrees. As stated, this is the normal angle of deflection, *i e*, the forefoot is adducted with relation to the heel from 25 to 30 degrees. If the angle is lessened by deflection of the forefoot, in an outward direction, at the mediotarsal joint, the foot is abducted and constitutes talipes valgus or flat foot.

The inner border of the foot should present a relatively straight line from the heel to the inner side of the great toe, from the first to the last phalanx. The concavity of

A straight line from the center of the heel through the ball of the great toe should pass through the center of the distal end of the great toe in order to insure the proper angle of deflection of the forefoot to the heel and proper alignment of the phalanges to the metatarsal of the great toe (Meyer's line).

In the normal foot, the tubercle of the scaphoid will be found on a line drawn from the lowest point of the internal malleolus to the tubercle of the first phalanx of the great toe. In the lowered arch, the tubercle of the scaphoid will appear below this line and in an arch abnormally high, it will appear above this line (Feiss' line).

The foot is so constructed so as to combine both strength and mobility. Strength is achieved through the bones being short and solid, well compacted together in the form of a double arch, joined by strong ligaments and supported by powerful muscles.

Mobility is obtained by the bones and joints being numerous and the muscles highly specialized

The main weight is transmitted through the internal set of the anteroposterior arch which is in relation with the tibia. The external set is in relation with the fibula.

The main function of the internal portion of the foot is support, that of the external portion is balance. The weight of the body is transmitted along the astragalus in three directions, *viz*, backward, to the tuberosities of the calcaneum, forward, to the heads of the metatarsal bones, and laterally, toward the base of the fifth metatarsal bone.

The posterior pillar of the anteroposterior arch is short and thick. Composed of only two bones, the astragalus and os calcis, it is stiff and strong, but having but two parts, is comparatively immovable. The anterior pillar of the arch is longer and has more bones, and while not so strong against static pressure as the posterior pillar, is on account of its elasticity of specific value against dynamic (active) pressure. This is well illustrated by the fact that a fracture to the os calcis or astragalus of the posterior pillar is the ordinarily expected result when an individual leaps from a height and alights on the sole of the foot, whereas, upon such occurrence the bones of the anterior pillar escape without injury. In this situation, the internal part of the foot yields more readily than the external, for the latter is practically in contact with the ground, while the former part has, as its support, ligaments and muscles, and when these give way, it is the inner side of the foot which sinks. This condition is also contributed to by the position of the tuberosities of the os calcis with reference to the ankle joint, for they are not directly beneath it but somewhat to its outer side.

Only in the subastragaloid joint does any considerable motion take place, while a lesser amount occurs at the midtarsal joint. The contiguous tarsal bones are joined by numerous band-like capsular and interosseous ligaments which allow a limited amount of movement between them.

In the aggregate these movements are considerable and make the foot as a whole quite flexible.

The three principal axes of movement of the foot are

- (1) Transverse, through the lower part of the astragalus. The movements of the ankle are dorsal and plantar flexion.
- (2) Longitudinal, parallel with the long axis of the foot, through the subastragaloid joint. The motion here is in the direction of inversion and eversion of the sole.
- (3) Vertical, through the mediotarsal joint, with motion producing abduction and adduction of the forefoot.

In the upright position, the highest point is that between the occiput and atlas, and the lowest that of the ankle. To enable the body when upright to be in a state of rest with the least amount of exertion, these joints are placed almost vertically one above the other. A vertical line through the center of gravity must fall within the arch of the foot as its base of support. The body is in the position of greatest stability when the center of gravity passes through the astragalo-scapoid joint midway between the two points of the tubercle of the calcaneum posteriorly, and the head of the first metatarsal bone anteriorly. For lateral equilibrium, in the upright position, the center of gravity falls midway between the ankles of the two feet.

The foot at rest is plantar flexed, adducted and rotated slightly inward. During movement, the position of the bones is controlled by the muscles, when at rest, their position is governed by the ligaments, for the muscles are then relaxed. The weight of the body acts as a constant downward force, a situation of potential injury, were it not neutralized and balanced in the bones, ligaments, and muscles. Weakened ligaments in the foot is the primary cause of flat foot, for these ligaments give way when a standing person, in fatigue, assumes a position of rest, causing the muscles to relax and the joints to become extended—thus thrusting the body's weight upon these

weakened ligaments which, because of their condition, fail in their duty of support

When the long or longitudinal axis of the os calcis is altered as it is in lowering of the dome of the foot, the prominence of the heel is altered. In flat foot, the axis is changed from forward, downward, and outward, to forward, horizontal, and inward, resulting consequently in prominent heels.

The characteristic of the walk is the abduction, and listing of the foot to the inner side. Hence the soles of shoes are inevitably more worn along this side, also, the counter on the inner side may overrun the heel.

The dorsum of the trochlear surface of the astragalus increases in prominence, as does also the external malleolus. The altered direction of the long axis of the foot through much abduction of the forefoot causes the external malleolus to appear in substantial alignment with the internal malleolus, and, in aggravated cases, may even seem in advance of the internal malleolus. In neither case has any actual changes taken place in the relation of the tibia to the fibula.

The dome of the foot is obliterated. The eversion and rotation on the subastragaloid axis has so altered the position of the os calcis that its external inferior tubercle is lifted from the supporting surface, and an articulation may be formed between the external surface of the bone and the external malleolus. The anterior part of the os calcis has been abducted. The external arch with the entire dome has been lowered and the eversion has so rotated the bones that the cuboid is on about the same horizontal plane as the upper part of the head of the astragalus. The superior faces of the internal cuneiform and the first metatarsal and the upper part of the head of the astragalus look inward.

It is this rotation of the foot which throws the external malleolus into such prominence and correspondingly decreases that of the internal malleolus. The abduction of the forefoot gives the external malleolus the appearance of having been moved

to a position in advance of its normal one. The scaphoid may be greatly altered in shape, and its tuberosity look downward instead of inward, thus giving an altered direction to the tibialis posticus. The greater part of the inner surface of the head of the astragalus is uncovered as it is depressed and rotated inward, while the scaphoid in relation to it is displaced upward and outward. Exuberant bone may be present on what is now the outer and upper part of the head of the astragalus and also about the cuboidal facet of the os calcis.

The forefoot is abducted from overaction of abductor minimi digiti and peroneus longus and brevis, usually associated with pronation and eversion and the angle of deflection is less than 25° . The weight of the body transmitted to the foot tends to flatten the anteroposterior arch. In this process, either the astragalus is moved up, up-luxating, or the ligaments stretch or rupture, allowing the two pillars of the arch to separate.

There are three stages of the process of talipes valgus, *viz* (1) eversion, pronated foot, muscles give way first, foot everts mainly at subastragaloid joint, (2) descent of tarsal arch or flat foot, (3) later by a more complete eversion of pes valgus.

The basic explanation of flat foot is manifest. In short, unable to support the body weight on the weakened muscles, the patient relaxes, throwing the unaccustomed burden on the ligaments. These inevitably give way, the arch descends, and flat foot results.

X-RAY FINDINGS

Because of the bone and joint changes in flat foot of the spasmodic and osseous type, no upright posturing is needed.

In pronation of the calcaneum, the shadow of the lateral process of the tuberosity is absent.

Normally the free dorsum of the distal articular end of the astragalus forms a slightly concave line. Swelling ridges and formation of processes are all pathological caused by the abnormal form of the whole

arch of the foot The posterior process of the astragalus becomes larger and more irregularly edged

A broad gaping joint fissure on the dorsum between the astragalus, scaphoid, and cuboid indicates flat foot When the body weight is placed on the foot, the fissure becomes narrower

In flat foot, the articular edges frequently appear raised—a condition which is always combined with a bony swelling at the articular ends of the bones

In the normal foot, the plantar view of the scaphoid bone takes the form of a crescent In flat foot, it is more wedge-shaped

On the inner side of the tuberosity of the ischium there is developed a considerable button-like thickening of the bone Due to flat foot, an external gait, and flat pelvis, an exostosis is formed at the origin of the gracilis tendon The pelvis is turned from the normally inclined position, and ele-

vated to the flat position at the anterior edge

Thanks are due to the Clay-Adams Co., of New York City, who were kind enough to furnish us with the microtome section and the skeletons of the foot, which are used in this article

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ROENTGEN MENSURATION BY STEREOROENTGENOMETRY¹

By CLAYTON R JOHNSON, M D , *Los Angeles*

STEREOROENTGENOMETRY is a descriptive name for a method of roentgen measurement whereby the solid dimensions of a radiopaque object may be determined from its stereoscopic radiograms. The basic principle involved is that known as "the Cross-thread Method of Localization," described by Mackenzie-Davidson, in 1896 (1), who established the fact that it is possible and practical to

THE PRINCIPLE OF STEREOROENTGENOMETRY

In Figure 1-A, XY represents a radiopaque object somewhere in space between the target of the tube A and the film FF' . When the focal spot of the tube is at A , the shadow of XY will be cast on the film as $AX\ AY$. The target of the tube is then shifted to position B and the

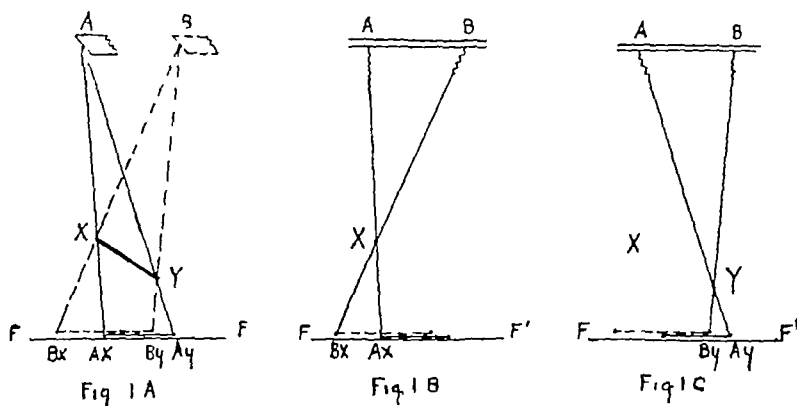


Fig 1 Illustration of the principle of stereoroentgenometry. See text for description

reconstruct, by mechanical means, a phantom image of an object from its shadows on stereoscopic radiograms.

Later, in 1911, Manges (2), using the same principle, measured the bony pelvis of pregnant women.

On previous occasions (3, 4, and 5), the author has described his original apparatus and method for roentgen measurement of radiopaque bodies. The method has proved practical and accurate for pelvimetry, for the localization and measurement of foreign bodies, for the measurement and localization of sinus tracts filled with opaque media, and for other similar diagnostic problems.

shadow XY is cast on the film as $BX\ BY$. The distance from A to B is known, the distance from A to FF' is known, the position of the film FF' with relation to the tube position A and B is known, therefore, it becomes a simple procedure to reconstruct a phantom image of XY in the following manner.

In Figure 1-B, the apparatus (the stereoroentgenometer) is so constructed that the positions A and B and FF' are in identical relationship as that of Figure 1-A. Flexible wires are stretched from A to AX and from B to BX . The point at which the wires cross will be the location of X in space with relationship to the film when the radiogram was made. This point is fixed by means of a pointer.

In Figure 1-C the wires are stretched to

¹ The stereoroentgenometer is being manufactured and distributed by the Standard X-ray Co., Chicago, Illinois.



Fig 2 The patient lies in a comfortable supine position and stereoradiograms are made. Any technician with average skill can make these radiograms. The Bucky tray has been pulled out to show the cassette and special marker.

$B1$ and AY , this locates the point 1 in space. We have now constructed a phantom image of the object 1 in space, and its size may be measured directly with a rule. The distance 11 may represent the true conjugate of a pelvis, the diameter of a bullet, or the size of a sinus tract filled with opaque media.

ROENTGEN PELVIMETRY

Since the introduction of the method in 1927, the author has used the system successfully in several hundred cases of roentgen pelvimetry and some very definite conclusions have been drawn. Although practically every type of pelvic deformity described has been discovered in these examinations, the percentage of significant disproportion between the fetal head and the maternal pelvis is probably less than 1 per cent and certainly not so frequent as suspected from clinical examinations upon which elective operative procedures are instituted.

The technique of examination for pelvim-



Fig 3 Illustration of an obliquely contracted or Nagele type of pelvis. All diameters of the inlet, outlet, and fetal head are readily obtainable. Stereoradiograms are available for locating anatomical landmarks for measurement for determining the position of the head and for studying the contour of the pelvis.

etry has had no important changes since that described on previous occasions. The patient lies in a comfortable supine position and stereoradiograms are made (Fig 2). Any technician with average skill can make these radiograms. As applied to pelvimetry, any desirable diameters (Fig 3) of the pelvis and fetal head are readily obtainable. Stereoradiograms are at the same time available for study as to the general contour of the pelvis and position of the fetal head. Any method of roentgen pelvimetry which provides less information is inadequate.

From experience, it has been found practical to determine the true conjugate, the right oblique, and the left oblique diameters of the inlet. Any true conjugate above 10.5 cm should be considered adequate. At the outlet, the bis-ischial and posterior sagittal diameters are most important.

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THE PRINCIPLE OF STEREOROENTGENOMETRY

In Figure 1-A, X represents a radiopaque object somewhere in space between the target of the tube A and the film FF' . When the focal spot of the tube is at A , the shadow of X will be cast on the film as AXA . The target of the tube is then shifted to position B and the

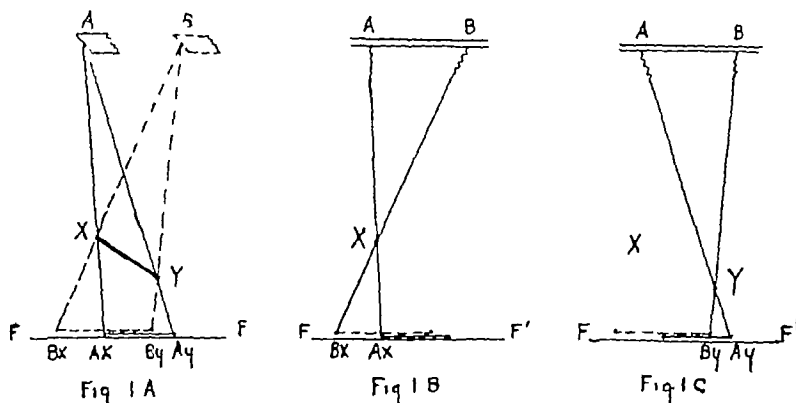


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¹ The stereoroentgenometer is being manufactured and distributed by the Standard X-ray Co. Chicago, Illinois.

CONGENITAL BRONCHIECTASIS IN CHILDREN

By GEORGE S REITTER, M D , *East Orange, New Jersey*

A SURVEY of the literature reveals that there have been comparatively few cases of congenital bronchiectasis reported since Lænnec, in 1819, first drew attention to this condition. There seems to be little or no disagreement among some recent writers that bronchiectasis in children is of congenital origin. The clinical aspects are well known and

of bronchiectasis in children is considered to be the result of long-continued coughing, and there is little doubt that infantile bronchopneumonia and whooping cough do modify the bronchial walls and destroy their elastic armor thereby causing a secondary dilatation, one must always consider that the accidental malady is often only the occasion which brings out a latent

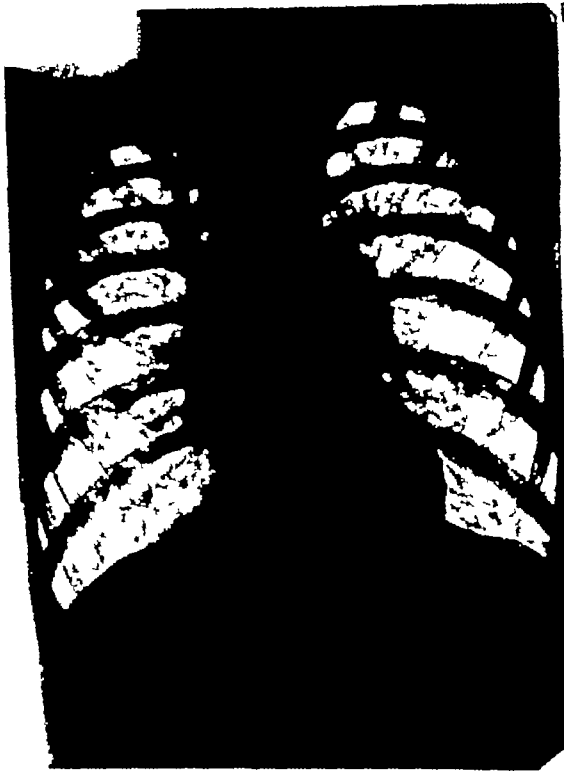


Fig 1



Fig 2

Figs 1 and 2 Congenital bronchiectasis. Multiple globular cavitations are present throughout both lungs with considerable infiltration along the bronchi.

need not be described. The pathologic-anatomic characteristics however should be discussed.

Anatomists admit four types of bronchial malformations: (a) pulmonary agenesis and hypoplasia, (b) fetal bronchiectasis including polycystic lung, (c) formation of bronchi in countless numbers, and (d) chondromas. Although the usual case

congenital lesion or that a congenital lesion may be present and is aggravated by an accidental bronchopneumonia. A congenital factor must be admitted with surprising frequency in any case. The pathologic characteristics are hyperplasia and rich vascularization, marked mutilation of the bronchial muscles, elastic tissue, and cartilages, whether the lesions are

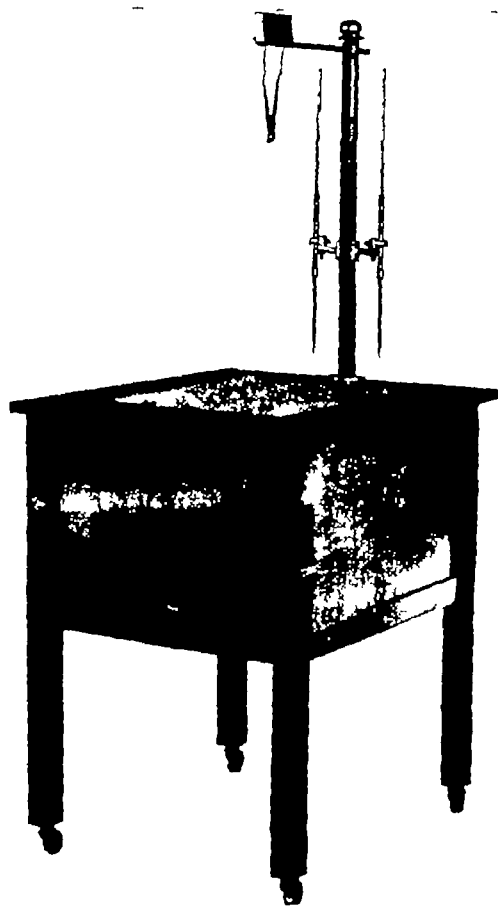


Fig 4 The stereoroentgenometer a practical device for roentgen measurement of the radiopaque objects

When the sum of these diameters are 17 cm or more, no difficulty should be experienced with the normal fetal head

COMMENT

The skill in interpretation of the findings is not difficult for anyone who can qualify as a roentgenologist. Roentgen pelvimetry opens a new field of great practical service for the roentgenologist. A well constructed, workable instrument (Fig 4) at comparatively low cost is now available.¹ It gives the roentgenologist a new, practical tool, universal in application in those instances wherein it is desirable to know the solid dimensions of radiopaque skeletal parts or objects within the human body.

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expiration was prolonged. The clinical impression at this time was that the patient had a right bronchiectasis, a second degree emphysema, and an amyloid liver.

At all times the patient ran a spiked temperature. Her total gain in weight during the six weeks in the hospital was four pounds. Postural drainage was tried for ten minutes every other day. The expectoration was a greenish muco-purulent material, which at one time was tinged with blood, probably due to the force with which it was brought up, for she often vomited food of the previous meal in these paroxysms.

The interest in this particular case arose from the problem of its differential diagnosis, *i e*, tuberculosis or congenital bronchiectasis. The patient had been classified as a case of active pulmonary tuberculosis by the County Tuberculosis Clinic. There was no history of tuberculous contacts in the family, and there were eight negative Mantoux tests. The fibrosis and infiltration in the bronchi, together with the en-

larged peribronchial lymph nodes, would suggest that the bronchiectasis was secondary to tuberculous lesions. The absence, however, of a definite clinical basis of tuberculosis would rule out this positive factor. The patient never had had whooping cough, pneumonia, or any other acute respiratory infection, which have been the commonly accepted causes of bronchiectasis. I am inclined to agree with Krampf, Saye, Herms and Mumme, and Lereboullet that there is a congenital basis for most cases of bronchiectasis in children, and that the diagnosis in this case should be congenital bronchiectasis.

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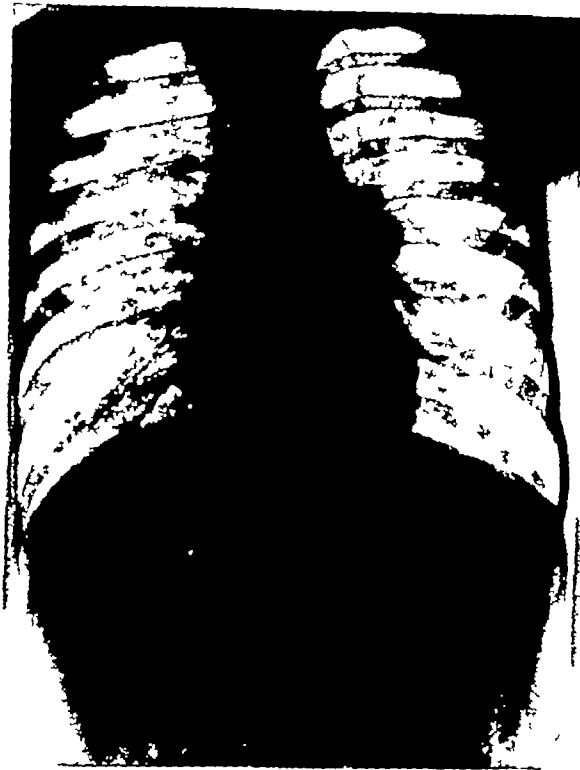


Fig 3

Fig 4

Figs 3 and 4 Same case after instillation of lipiodol into the right lower lobe

confined to one lobe or involve the entire lung

A case was admitted to the Essex County Isolation Hospital with the diagnosis of pulmonary tuberculosis from a County Tuberculosis Clinic. The patient, a white female of nine years, gave a history of having had chicken pox, measles, and mumps. The mother stated that she had always had some cough, which at times was productive, and that she had never been a robust child.

The following were the positive clinical findings. A poorly developed and poorly nourished child, not acutely ill. The tongue was coated, the skin warm and dry, and the muscles of the extremities had a wasted appearance. The fingers were clubbed. The cheeks were flushed. The chest was poorly developed, with retracted interspaces, and had marked osteopulmonary arthropathy. There was some tactile fremitus throughout, with the percussion

note dull over the left upper chest posteriorly. There were loud crackling râles over the entire chest, more marked in the apices and the upper portions of the lungs. The heart was normal. The abdomen was protuberant and hard but without muscle rigidity or tenderness. There was a non-productive cough and profuse night sweats. Eight tuberculin tests were negative. Repeated sputum tests and stomach washings were negative for tubercle bacilli.

The first roentgenologic examination was made after one week in the hospital, the second was made with lipiodol given by the bronchoscopic method at the end of a month.

Two weeks later, the liver was found to be hard and descended to about three fingers' breadth below the costal margin. This was believed to be an amyloid infiltration. The right side of the chest drooped. Râles were present throughout the entire chest, both on inspiration and expiration,

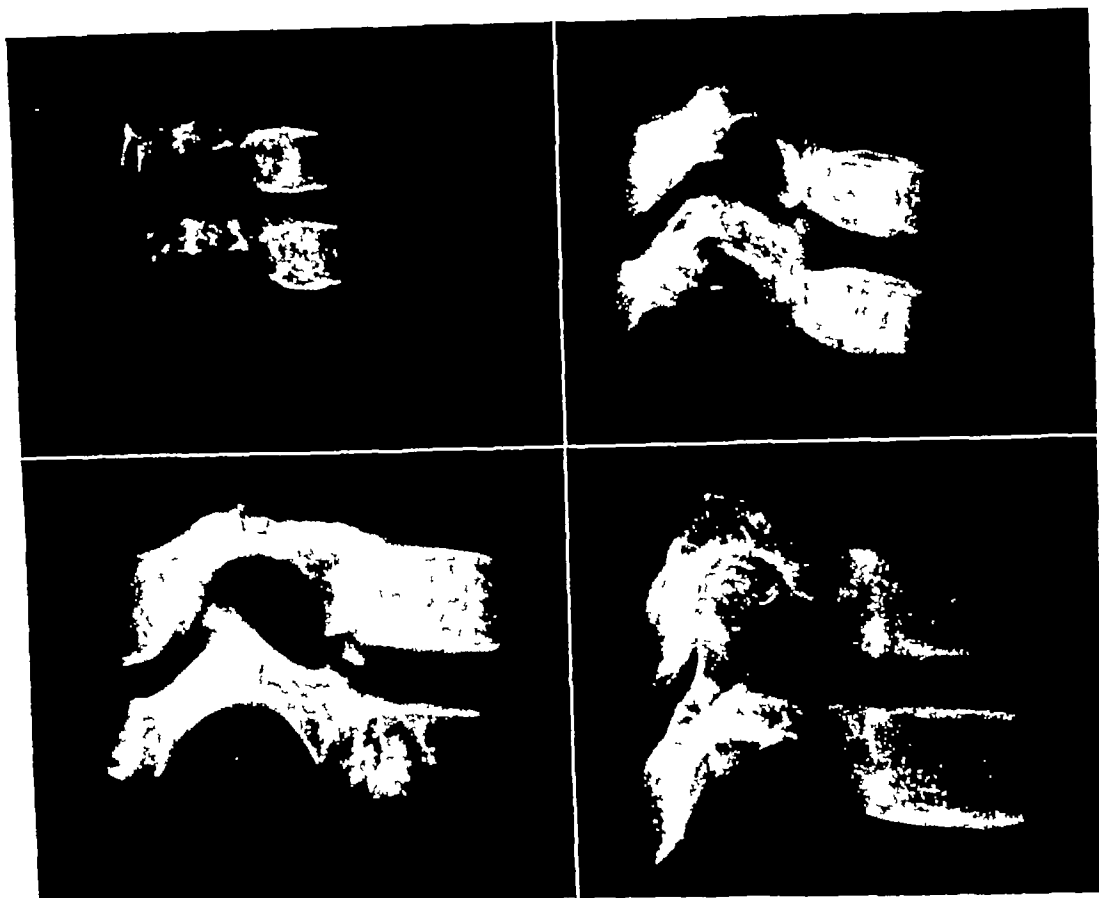


Fig 2 Lateral roentgenograms of the dorsal vertebrae (A) (upper left) at birth (B) (upper right) 6 months (C) (lower left) 1 year (D) (lower right) 2 years Well calcified articular facets are seen first in C

ance in roentgenograms during infancy varies widely, they are usually first seen between six months and two years of age. Microscopic sections made through the vertebral articular facets of children dying in early infancy show an osseous nucleus occupying the central portion of the facet, but this amount of ossification is not sufficient, usually, to produce a shadow in the roentgenogram (Fig 2). Clear definition of the articular margins is not commonly found before the age of eight.

Because of the peculiar contour of the vertebra, roentgenologic interpretation of changes in the articular facets is often difficult in roentgenograms of the spinal column taken in the customary manner. Special methods for obtaining roentgenograms of the articular facets have been reported by Lange (8) and by Ghormley

and Kirklin (9). In the upper cervical spine, the articular facets are best shown in roentgenograms taken through the open mouth. In the lower cervical region, lateral views provide a good picture of the facets. For the dorsal spine, rotation dorsally from 15 to 20 degrees from the true lateral view is suggested. In the first to the fourth lumbar vertebra, the articular facets are shown fairly well in anteropos-

TABLE I—ROENTGENOLOGIC CHANGES IN SPINAL ARTICULAR FACETS IN CHILDREN

Changes	No. of cases
Negative	203
Spina bifida occulta	89
Asymmetry of facets (on the two sides)	48
Elongation of tip of facet (sharpening)	23
Articular surfaces not parallel	22
Cases studied	500

In children, ankylosis of the articular facets cannot be ascertained with certainty in roentgenograms.

DEVELOPMENTAL CHANGES IN THE VERTEBRAL ARTICULAR FACETS

By JOHN G. KUHNS, M.D., *Boston, Mass*

GROWTH and differentiation in any part of the human organism usually progress in a definitely predictable manner. Such governed alteration in size and shape is well exemplified in the development of the vertebræ. Clinical experience has taught us that serious mechanical or metabolic disturbances are required to alter this pattern of growth. Bending is seen more commonly, in the long bones, but in all diseases leading to

and articular facets, or there may be wide lateral separation of the laminae, *e.g.*, spina bifida, causing the facets to be useless as joints. A more common change, especially in the lumbar region of the spine (3), is a variation in the shape and directional slant of one or both articular facets of a vertebra. One articular facet may be of the normal, crescentic type, while the other may be flat with a varying axis of the articular surface (4). Abnormalities of this sort lead to a difference in the relative stability of the two sides of the vertebral column, with changes in contour appearing in adult life. Strain of the back (5) and scoliosis (6) have accompanied such irregularities of structure (Fig. 1).

Changes in the vertebral articular facets occur from many causes during growth. This study was suggested by the changes observed in the articular facets in roentgenograms of children with scoliosis. An attempt was made to determine what structural alterations occurred in the articular facets of the spinal column before maturity was attained. Five hundred roentgenograms of the spinal column in children were studied to determine the presence and frequency of abnormalities in the vertebral articular facets. In the Warren Museum of the Harvard Medical School, an examination was made of the skeletons of children, as well as those of adults, with deformity. Portions of the dorsal spine were removed routinely at 50 autopsies upon children, and the articular facets of these specimens were studied macroscopically and microscopically.

The vertebral articular facets attain functional maturity as spinal joints at the seventh to the eighth month of fetal life. They are recognized in the cartilaginous extensions of the vertebral anlage in 14-millimeter embryos, and are found as separated, overlapping articular surfaces in 50-millimeter embryos (7). Their appear-



Fig. 1 The vertebral column of a child two years of age showing congenital abnormalities of the spine. There is a wide separation of the pedicles in the mid-dorsal region, and complete absence of the pedicle on the left side in the lumbar region.

osseous deformity there is a constant attempt on the part of the reparative forces of the body, probably through mechanical stimuli, to approach the normal contour of the bone.

Abnormalities in the vertebral articular facets may be found at birth, as Putti (1) and Wierszejewski (2) have shown. There may be complete absence of the pedicles



Fig 5 The spine of a boy 21 years of age who had tuberculosis of the spine since the age of seven There is fusion of the articular facets at the apex of the kyphosis

opposing articular surfaces With marked increase in the deformity, *e g*, tuberculosis, fusion of the articular facets about the apex of the kyphosis may occur (Fig 5)

In lordosis, there is a greater tendency to disalignment of the articular surfaces (Fig 6) In older individuals this is supplemented, not infrequently, by osseous proliferation about the margins of the facets, at times producing a hooked process which greatly limits motion In scoliosis, much less distortion of the facets is seen than would be expected In prepared spines with moderate scoliosis, the contour, directional slant and functional integrity of the facets are maintained surprisingly well In the severe curves, ankylosis of the articular facets occurs at the apex of the curve In rheumatoid arthritis involving the spine both in adults and in children, there is early ossification of the articular capsule, followed more slowly by ankylosis of the articular facets

These changes, however do not lead to noticeable changes in the internal bony architecture of the articular facets



Fig 6 Roentgenogram of a lumbar spine of a child seven years of age with extreme lordosis There is disalignment of the articulating surfaces of the facets

Microscopic study of the articular facets obtained at autopsies upon children showed no distinct changes in the internal architecture of the bone

These developmental changes in the vertebral articular facets may come on slowly or rapidly In metabolic disturbances, as in rickets, in diseases leading to the destruction of bone and after severe trauma they can occur in a short space of time In postural deformities and in scoliosis they arise more slowly Symptoms usually appear only after fairly extensive deformity of the articular facets has occurred (11) At first there is only slight interference of the functional activity of the spine, which steadily becomes more marked with increase of the deformity

In roentgenograms, as Lange (8) has shown, one of the earliest changes is a pointed appearance of the tip of the articular facet instead of the usual rounded con-



Fig 3 The lumbar spine with asymmetry of articular facets and osteoarthritis, and marked bony overgrowth about the facets

terior views. For the lumbosacral region, a diagonal view with the patient rotated from 45 to 60 degrees from the true lateral is advocated.

While special technic gives a less distorted and more clearly defined picture of the vertebral, articular facets, much can be learned from anteroposterior and lateral views of the spine. In good roentgenograms, the outlines of the articular facets can usually be determined on close scrutiny when the shadow of the pedicles or vertebral body is superimposed. Table I summarizes the findings in a study of 500 anteroposterior and lateral roentgenograms of the spine in childhood. Many more variations would probably have been found in older groups and if special roentgenograms for the articular facets had been taken.

The most common finding in roentgenograms is spina bifida. Somewhat less common is an asymmetry of the articular facets chiefly at the lumbosacral junction. Here, further changes take place in adult life, probably in an attempt to increase vertebral stability (Fig 3). Goldthwait



Fig 4 Child of 12 years with marked lordosis and asymmetry of the lumbosacral facets. Note the elongation of the facets on the right.

(10) and Ghormley (11) have shown that serious disturbances can follow such changes. With persisting anteroposterior and lateral deviations of the spine, developmental changes in the articular facets must, of necessity, occur with growth. They are recognized chiefly as a twist or an elongation (a "sharpening") of the tip of the articular facet (8) (Fig 4).

In specimens of the spinal column mild asymmetry of the laminae and slight changes in the length and directional slant of the articular facets are often found. Both in the milder anteroposterior and lateral deviations of the spine and in the more severe scoliosis and kyphosis accompanying out-spoken disease changes are found in the vertebral articular facets in fixed preparations. In the living, these changes are often not perceptible in roentgenograms. In kyphosis, there is first seen an increased anteroposterior inclination of the facets, with a fairly constant maintenance of the parallel position of the

EDITORIAL

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NEXT ANNUAL MEETING

DEC 2-6, HOTEL STATLER, DETROIT

This is the time when members and friends of the Radiological Society of North America are making plans to attend the Annual Meeting, and for that reason it has seemed fitting to say a little about the city of Detroit, this year's meeting place. The modern city is intimately known to many, but a brief résumé of the colorful history may be of interest—how many of us who think of Detroit as the automobile capital of America have ever stopped to think of the reason why a settlement was first located on that site or the trading center which antedated the automotive industry.

The building of Detroit on a spot where Nature has fashioned something splendid was partly out of circumstance, partly out of necessity, and partly because of a very localized convenience. When Cadillac moved across Lake Erie and swung north up the Detroit River he saw the calm blue of these northern waters sheltered from the fury of the Great Lakes by an island at each end, and on the west bank of the river he noticed a slight promontory, overlooking the surrounding country, an ideal spot for his sentinels to watch the movements of the Indians and the British who were gradually encroaching upon the territories of New France and threatening to annihilate the power of France in America.

He built a rude settlement on the rim of this northern wilderness, a savage outpost touched feebly by the stray glints of French chivalry and nobility, holding in its feeble fist the touchstone of the power of the Bourbon dynasty. And the little settlement shambled along the banks of the river, slowly and bravely, anxious about Indian outbreaks and massacres. Through the bleak winters it staggered as hungry as a ghost, ill supplied and out of the reaches of civilization.

Then one day General Wolfe swept the Plains of Abraham, conquered the French with a superior force, and all the lands of the St. Law-

rence, Ohio, and Mississippi Valleys were surrendered to Great Britain. The power of France was broken in North America. Detroit became a British possession. It remained so until 1783, when America broke with England. It has since remained under American rule with the exception of a short period during the War of 1812 when the British flag flung its defiance out across her battlements.

The nineteenth century gave birth to a culture that still clings traditionally to the city—a culture that was ripe and glowing before the automobile swept in upon us and our industry in its maddened pace. The middle of the nineteenth century saw a slow and continued growth, a sound healthy condition of business pioneered by men who loved business and its gifts to civilization, men satisfied with small profits but sound financial policy. It is a simple story—how these men rose to wealth and affluence with the success of their business, how they found time, in their slow deliberate pace, to set up a distinct culture, in a society that was born out of savage manners and polished by the glint of the courts of France.

Jefferson Avenue was at one time Detroit's Riviera, colored with fashion, glowing with French manners, styled with aristocracy. Such names as Antoine, Beaubien, Chene, St. Aubin, and Joseph Campau are woven in the familiar scene of old Detroit. Like the ivy clinging to the ancient ruin, Jefferson Avenue refuses to surrender its fascinating character to a mere memory and clings to the early romance of this city. Former wealth paraded here on foot, now it whizzes by in limousines, without a thought, no doubt, of the former gay splendor that feasted here.

Detroit was almost destined to be erased from the business picture of the country. The city was polishing her manners. It was growing, but slowly. People here were more interested in the quiet luxuries of living than in the

tour of the end of the facet. In anteroposterior disturbances in vertebral alignment, the parallel position of the articular surfaces of the facets is changed, but secondary arthritic changes develop very slowly. In scoliosis, the articular surfaces are pressed firmly together on the concave side but are separated on the convex side. Torsion of the vertebral bodies may produce a sagittal or frontal separation. Fractures usually produce easily observable shadows if the roentgenograms are taken in a special manner to show the articular facets. Occasionally, as was shown in one roentgenogram studied, a congenital separation of the tip of the articular facet may be present. The absence of the usual signs of fracture will help in the diagnosis of this condition. Dislocations of the facets may occur after slight or more severe injuries (12). In such injuries, structural changes in the articular facets develop rapidly if reduction is not accomplished.

The seriousness of these deformities of the vertebral articular facets and the symptoms which they produce vary widely. It is evident that their presence at times prevents correction of spinal deformity and limits vertebral motion. That they can lead to serious neurologic symptoms has been shown by Gunther and Kerr (13), and by Ghormley (11). The less severe changes in the articular facets often lead to osteoarthritic changes by the mechanical disalignment and by the interference which they produce in articular motion.

CONCLUSIONS

(1) Deformities of the vertebral articular facets occur frequently with spinal deformities and with diseases and injuries involving the vertebrae.

(2) These deformities are best shown in

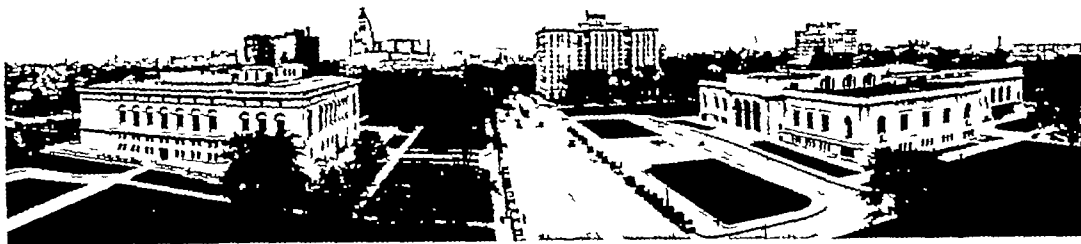
roentgenograms by special technique but are often visible in ordinary anteroposterior and lateral roentgenograms of the spinal column.

(3) The usual deformities of the facets found in roentgenograms and in cleared specimens are (a) disalignment of the articulating surfaces, (b) proliferative changes, either hook-like projections about the margins or an elongation of the tip of the articular facet, (c) ankyloses of the facets.

(4) These changes, although mild and symptomless in childhood, may hinder correction of a spinal deformity, and may lead to the development of osteo-arthritis about the facets and irritation of the spinal nerve roots.

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Detroit's famous Art Center showing the Detroit Institute of Arts and the Detroit Public Library

PUBLICITY CHAIRMAN'S PLANS

The twenty-first annual meeting of the Radiological Society of North America will be held in Detroit at the Hotel Statler, December 2 to 6, inclusive. This year is the fortieth anniversary of the discovery of the roentgen ray. The Radiological Society of North America is just one-half that age.

Everything is in readiness for a great meeting. Improved economic conditions forecast a large attendance. The program is the best in years, giving evidence of an efficient and industrious Program Committee and denotes our progress and experience. As each section is arranged under a symposium, papers on allied subjects will be read consecutively—the ideal manner in which to present a program. The essayists have had wide and special experience and are well fitted to present their subjects.

Howard P. Doub, M.D., Chairman of the Committee on General Arrangements, and Lawrence H. Reynolds, M.D., Chairman of the Local Committee on Publicity, have been untiring in our behalf and preliminary reports indicate that our stay in Detroit will be enjoyable and profitable.

The commercial and scientific exhibits will equal, if not surpass, our standard of former years.

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Many perplexing problems confront us in a rapidly changing world.

WILLIAM J. CORCORAN, M.D., *Chairman,*
Publicity and Educational Committee

GREENFIELD VILLAGE

How interesting it would be if we could turn back the pages of time and see how our forefathers lived! Realize the simplicity of their daily life! Note the progress through the years!

That, to some extent, can be done in a trip through Henry Ford's Greenfield Village near Detroit. It has become one of the most interesting places to visit on the continent. Many newly-weds now visit Greenfield Village on their honeymoon.

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Skyline of Detroit

tenure of a strictly industrial and business complex and Detroit was advertised as a "city where life is worth living." Meanwhile other cities had become great—Chicago, Philadelphia, New York, Boston, Cleveland, St. Louis, Cincinnati, Baltimore, and the West, all gathering a quick momentum to build gigantic perspectives of business, a growing sense to pile cities in the air and heap our American wealth. This psychology began to grow in the middle of the nineteenth century. It was the beginning of our metropolitan immensities of today.

Then something happened at Detroit. Near the end of the nineteenth century, a new era was describing its trajectory in the sky. Some of the first experiments on gasoline engines were being tried. Organizations had been formed and failed. Thousands of dollars were being invested and lost. A group of young men, men of business and vision, just a few, strode into those gargantuan battles of finance and personality and won. Many lost with sick hearts. It was the battle of the mighty—mighty minds, mighty wills, mighty energies.

Steam, electricity, and gasoline fought it out on the streets of the towns and the villages of the country. Gasoline won—and out of the thickets of the nineteenth century came a new civilization—a civilization on wheels. Great men had put it there. The tallow of the night watch had burned low over experiments and ugly words. Machinery became the dominant force, the internal combustion engine its dynamo.

An old civilization was reeling then. Things were changing so rapidly that men were winning fame overnight, the men who were prepared for fame, those who saw the fingers of

the times tracing new and strange characters on the wall. Some were caught in the eddying torrent, unable to extricate themselves. Some blundered and foundered. Other blustering fellows rushed in, were caught in its tentacles and whirled to fortunes. A new world of machinery had hurried down upon mankind and men could see its forces being driven from Detroit to the ends of the earth.

And so Detroit became an industrial city, and after our factories were built, we built schools and colleges, libraries and museums, beautiful theaters and office buildings, parks and boulevards. Some of our theaters are among the largest in the world. Others are unique in their strange barbarian architecture. With the beauty of the city's natural setting in this paradise of waters, visitors will find a wealth of interest. Detroit has cultural and educational phases that are known throughout the world, beautiful school buildings, and one of the most complete educational systems in the country.

Detroit presents to the imagination a succession of panoramas in history and legend. The Detroit City Hall has long been surrounded with the sentiment of tradition. Modern business progress demanded a new structure to replace the old, but sentiment has preserved the glow of its historical associations and the building still stands. One can well imagine the genius of the place gazing out reminiscently over the huge skyscrapers. The present building is one of the spots in the city that has not passed into a sacredly venerated memory. It still traces its shadows at the feet of mighty monarchs of modern business, protected from utilitarian vandalism by the tendrils of a sacred tradition.



Detroit's famous Art Center showing the Detroit Institute of Arts and the Detroit Public Library

PUBLICITY CHAIRMAN'S PLANS

The twenty-first annual meeting of the Radiological Society of North America will be held in Detroit at the Hotel Statler, December 2 to 6, inclusive. This year is the fortieth anniversary of the discovery of the roentgen ray. The Radiological Society of North America is just one-half that age.

Everything is in readiness for a great meeting. Improved economic conditions forecast a large attendance. The program is the best in years, giving evidence of an efficient and industrious Program Committee and denoting our progress and experience. As each section is arranged under a symposium, papers on allied subjects will be read consecutively—the ideal manner in which to present a program. The essayists have had wide and special experience and are well fitted to present their subjects.

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early American home Most of the conventions now meeting in Detroit include on their entertainment program for the ladies a lunch at Dearborn Inn and a trip through Greenfield Village

Men, too, find the Village interesting, for combined with it is the Edison Institute which graphically illustrates the birth of American inventive genius and the progress of industry

Few realize the magnitude of the task of gathering the parts that together make a typical American village of long ago There is nothing like it anywhere else in the world There are early American homes complete with their antique furniture, spinning wheels, looms, quilting frames and all the other appurtenances of home-making back when "man works from sun to sun, but woman's work is never done" was more than a saying

Facing the village green stands Clinton Inn, famous hostelry, built in 1830, and an important stop for stage coaches on the Chicago turnpike Nearby are the village general store, the barber shop, the village blacksmith's forge, and the old grist mill that stood for more than a

century on the banks of Stony Creek at French town, near Monroe, Michigan

Then there's the wagon works and harness shop, the prim New England church, and the little red school house where Henry Ford, himself, once went to school Recently, the home of Stephen Collins Foster, author of "Old Black Joe," "Suawnee River" and many other favorites, was uprooted from the center of noisy Pittsburgh and re-erected in the ever-growing village of American memories Near by a restored stern-wheel steamboat gently rises and falls with the current of the River Rouge

So Detroit, the city that put the Nation on wheels and changed the tempo of living, has on its outskirts in Greenfield Village a living page of history, not of battles and conquests, but of the simple lives of our forefathers, their hardships and comforts, their triumphs in art and industry

If you would turn back the pages of history, plan your trip to Detroit to include a visit to Greenfield Village



Greenfield Village

ADDITIONAL SYMPOSIA¹

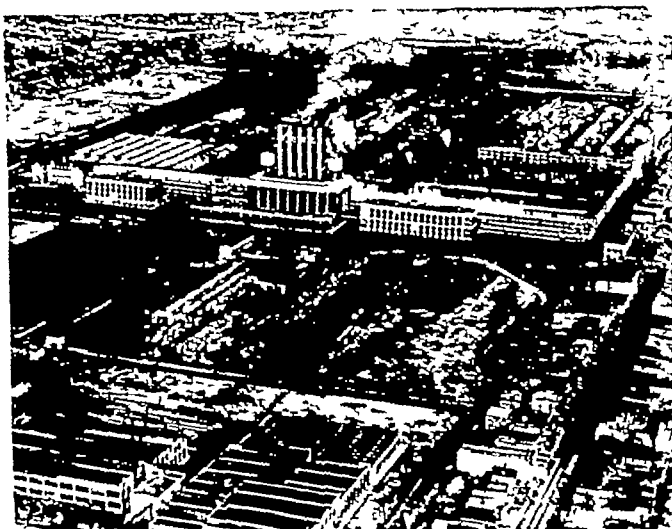
THORACIC PATHOLOGY

Arranged by HARLAN P. MILLS, M.D.,
Phoenix, Arizona

- 1 ERNST A. POHLE, M.D., Ph.D., Professor of Radiology
- L. W. PAUL, M.D., Assistant Professor of Radiology, and
- W. H. OATWAY, JR., M.D., Assistant in Medicine, University of Wisconsin Medical School, Madison. Routine Roentgen Examinations of the Chest of Patients Admitted to the State of Wisconsin

Pathological Laboratory, Department of Surgery, Johns Hopkins Hospital and University, Baltimore. Intrathoracic Tumors (Illustrated with lantern slides)

- 2 JOHN T. FARRELL, JR., M.D., Assistant Roentgenologist, Jefferson Hospital, Philadelphia. The Responsibility of the Radiologist in the Diagnosis and Treatment of Pulmonary Malignancy
- 3 D. E. EHRLICH, B.A., M.D., and H. A. HAUPTMAN, M.D., New York City Cancer Institute, New York. Primary Carcinoma of the Lungs



Ford River Rouge Plant

- General Hospital during a Three month Period
- 2 LEO G. RIGLER, M.D., University of Minnesota Hospitals, Minneapolis. Atypical Distribution of Pleural Effusions
 - 3 RAY A. CARTER, M.D., Roentgenologist, Los Angeles County General Hospital, Los Angeles. Pulmonary Mycotic Infections (Illustrated with lantern slides)
 - 4 THOMAS R. HEALY, M.D., Boston. Yeast Infection of the Lungs (Form of title may be changed)

INTRATHORACIC NEOPLASTIC DISEASES

- 1 CHARLES F. GESCHICKTER, M.D., Surgical-

¹ These are in addition to the announcements of symposia published in RADIOLOGY for September 1935

- 4 SAMUEL BROWN, M.D., Assistant Professor of Roentgenology, University of Cincinnati, and JUSTIN E. MCCARTHY, M.D., Good Samaritan Hospital, Cincinnati. Intrathoracic Tumors. Their Diagnosis and Treatment

A CORRECTION

In the August issue, page 240, in the review of 'Clinical Pathology of the Jaws, with a Histologic and Roentgen Study of Practical Cases,' the author's name should read as follows "By Kurt H. Thoma, D.M.D., Charles A. Brackett Professor of Oral Pathology," etc. Apology is herewith offered to the author and publisher of the work for an inadvertent error

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Greenfield Village

BOOK REVIEWS

DIE THEORETISCHEN GRUNDLAGEN UND MÖGLICHKEITEN DER RÖNTGENDIAGNOSTISCHEN WEICHTEILUNTERSUCHUNG (The Theoretical Foundations and Possibilities of Roentgen Diagnostic Studies of Soft Tissue) By ADOLF ZUPPINGER, Assistant, Röntgeninstitut der Universität, Zurich. A volume of 99 pages, with 46 illustrations. Georg Thieme, Leipzig, 1935. Price, M 16, geb M 18.

Good roentgenograms of soft tissue require a very accurate technic since the differences in absorption between the various elements involved are quite small. So far the procedure has been more or less empirical and here is where the investigations of Zuppinger create an entirely new basis. By studying from a physical standpoint the characteristics of films, intensifying screens, spectra of the radiation used in radiography, the qualitative and quantitative changes of the rays after passing through tissues, and the ways and means to overcome certain shortcomings, he arrives at definite deductions regarding the optimal exposure technic. One important phase of his work concerns the efficacy of contrast media. It appears that iodine is the least efficient, with thorium topping the list and silver and bismuth running close seconds. Selenium seems to be the best filter material for radiographic purposes. One table in this monograph shows the absorption coefficients of the various tissues as well as of the most common foreign bodies. The special exposure technic for demonstrating varicose veins in the esophagus, the visualization of the hypopharynx, including the use of a contrast medium, and the radiographic demonstration of the epipharynx are described in detail. A number of excellent illustrations are used throughout the text.

This monograph by Zuppinger fills an urgent need in the radiographic literature. While only a few points can be mentioned in a brief review, an attempt has been made to give at least some idea of the wealth of accurate information offered by the author. The book is heartily recommended, therefore, to the radiologist who understands scientific German and it is hoped that an English translation will be made available soon.

APPARATUS AND TECHNIC FOR ROENTGENOGRAPHY OF THE CHEST By CHARLES WEYL and S. REID WARREN, JR., Moore School of Electrical Engineering, University of Pennsylvania. A volume of 175 pages and 35 illustrations. Charles C. Thomas, Springfield, Ill., 1935. Price, \$5.00.

The publication of this book may well be said to signify the coming of age of roentgen diagnosis. That the latter has assumed sufficient importance in modern medical practice to necessitate a monograph on the technic of one small phase of roentgenology should be a source of gratification to all those who are laboring in this field.

It is fitting that a book on the technic of chest roentgenography should be issued from Philadelphia (it is a product of the Moore School of Electrical Engineering of the University of Pennsylvania), where the work of McPhedran, Pancoast, and Pendergrass, and numerous others, has done so much to make the roentgen diagnosis of lung diseases possible.

This small volume covers the entire field of roentgen diagnostic technic, as related to the chest, from the proper installation of the electrical supply and the choice of transformer to the construction of the viewing box. These technical details are considered from the point of view of the fundamental physical principles underlying them rather than from the practical technical standpoint. The numerous experiments undertaken by the authors to establish these principles are described in comprehensive form. Nevertheless, there is considerable attention to the practical details of the production of a roentgenogram. Certain important data such as the positioning of the patient or the centering of the tube are not given—possibly because they appeared to be too obvious. On the whole, however, few details are overlooked, and there are some quotations from the literature, particularly as to the work of R. B. Wiley.

The book presents a valuable guide to the fundamental principles involved in all x-ray diagnostic techniques. In certain portions the material may appear rudimentary to the practicing roentgenologist. Many of the details are well known. Nevertheless, it is well to have them presented as clearly and concisely as is here done.

A few concrete illustrations may serve to indicate the scope of the material presented.

LIST OF DETROIT HOTELS

Hotel	No of Rooms	SINGLE		DOUBLE		TWIN BEDDED	
		With Bath	Without Bath	With Bath	Without Bath	With Bath	Without Bath
Abington 700 Seward	135 Suites, \$50 up monthly	\$2 50 up		\$3 50 up			
Belcrest 5440 Cass	135 Suites, \$50 00 up monthly	\$2 50 up		\$4 00 up			
Book-Cadillac Washington Blvd	1200	\$3 00 up		\$4 50 up		\$5 00 up	
Briggs 114 W Adams	200	\$2 00 up		\$3 00 up		\$4 00 up	
Dearborn Inn Dearborn, Mich	100	\$3 00 up		\$5 00 up		\$6 00 up	
Detroit Leland Cass at Bagley	800	\$2 50 up		\$3 50 up		\$4 50 up	
Fort Shelby Lafayette at First	900	\$2 00 up	\$1 50 up	\$3 00 up		\$4 00 up	
Lexington 2970 W Grand Blvd	100	\$2 00 up	\$1 25 up	\$3 00 up	\$2 00 up	\$3 00 up	
Madison Lenox Madison and John R	300	\$2 00 up	\$1 25 up	\$2 50 up	\$2 00 up		
Norton Jefferson and Griswold	250	\$1 50 up	\$1 25 up	\$2 50 up	\$2 00 up		
Norton Palmer Windsor, Ontario	200 Suites, \$6 00 to \$8 00 daily	\$2 50 up	\$1 50 up	\$3 50 up	\$3 00 up		
Palmetto John R and Hancock	331	\$2 50 up		\$4 00 up		\$4 00 up	
Seward 59 Seward Ave	561 Suites, \$50 00 up monthly	\$2 50 up		\$3 50 up			
Statler Grand Circus Park	1000	\$2 50 up		\$4 50 up		\$5 00 up	
Tuller Hotel Park and Adams	800	\$2 00 up		\$3 50 up			
Wardell Kirby at Woodward	627 Suites, \$65 00 up monthly	\$3 00 up		\$4 00 up		\$4 00 up	
Webster Hall 111 Putnam	800	\$2 00 up	\$1 25 up	\$3 00 up	\$2 00 up	\$3 00 up	
Whittier 400 Burns Drive	816 Suites, \$65 00 up monthly	\$3 00 up		\$5 00 up		\$5 00 up	

ABSTRACTS OF CURRENT LITERATURE

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THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

J N AVE M D of New Orleans, La	HANS W HEFKE M D of Milwaukee Wis
S M ATKINS M D, of Waterbury, Conn	H A JARRE M D of Detroit, Mich
G E BURCH JR M D, of New Orleans La	DAVIS H PARDOLL M D, Chicago, Ill
E A POHLE M D Ph D of Madison Wis	

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The authors wisely caution against the use of very low voltages in chest roentgenography. They call attention to the discrepancy between the milliamperes-seconds and the degree of exposure when widely variable exposure times are used. They agree with Wilsey that an exposure time of $\frac{1}{10}$ to $\frac{1}{30}$ of a second is the most advisable under present conditions. There is a short criticism of the use of x-ray

paper and of portable x-ray machines of insufficient power in tuberculosis surveys. Numerous exactly detailed methods are described for testing screens, cassettes, films, dark room equipment, tubes, etc. While most of these are familiar to the experienced roentgenologist, it is valuable to have them set down so that they can be referred to upon occasion. The book is thoroughly recommended.

BIOLOGIC EFFECTS OF RADIATION

High Speed Electrons and Their Significance in Radiation Therapy R Glocker *Strahlentherapie* 1935 53, 417-423

The author studied the effect of high speed electrons produced in a specially constructed tube at 1.6 million volts on the eggs of *Drosophila*. It appeared that the percentage depth dose in a certain depth was higher than the surface dose in the extreme case as much higher as 50 per cent. This is in contrast to roentgen rays in which the dose in the depth is lower than the surface dose.

Glocker describes briefly an apparatus which is under construction and will be used in clinical tests for superficial therapy, it is supposed to operate at 2.5 million volts. He believes that the therapeutic use of high speed electrons is the method of the future and that the necessary equipment with potentials up to 20 million volts will soon be available.

ERNST A. POHLE M.D. Ph.D.

Radiation Genetic Experiments Dealing with the Time Factor on the Fruit Fly N. W. Timoféeff, R. S. Rössovsky and K. G. Zimmer *Strahlentherapie* 1935 53, 134-138

The authors studied the effect of the time factor on the rate of mutation in the fruit fly. They varied the intensity in the ratio of 1:300 and the total time of irradiation in the ratio of 1:1.440. In both cases the exposure of 3,000 r produced identical rates of mutation. It is concluded therefore that the order of magnitude of the dose controls the rate of mutation and not the time factor.

ERNST A. POHLE M.D. Ph.D.

BONE DISEASES (DIAGNOSIS)

Multiple Spontaneous Idiopathic Symmetrical Fractures Louis A. Milkman *Am. Jour. Roentgenol. and Rad. Ther.* November 1934 32, 622-634

The author reports a case followed over an eight year period with postmortem findings that he believes is a new skeletal disease which is progressive and may be fatal. The characteristics of this disease are the disturbance in gait, pains in the back, and involvement of the skeleton.

The characteristic roentgenographic appearance is bands or zones of increased transparency seen throughout the involved bones. They are multiple and symmetrical. The etiology is unknown. The parathyroid glands were not involved. Increased vascularity at the transparent zones was present, suggesting trophic disturbance. The patient was 13 years of age when symptoms began.

S. M. ATKINS M.D.

Contribution Concerning Osteochondritis Dissecans P. Kroker *Röntgenpraxis* July 1935 7, 455-460

Trauma and embolic processes are thought to be the cause for aseptic necrosis in the epiphyseal region of

several bones. Since Rahm has described a familiar occurrence of osteochondritis in six members of one family, the possibility must be considered that local causes are not the only bases for this disease. Some cases reported by the author seem to show that trauma is not necessarily an etiologic factor but that there must be a congenital inferiority of the skeletal system.

HANS W. HEFKE M.D.

Osteochondritis J. F. Brailsford *British Jour. Radiol.* February 1935 8, 87-134 (Reprinted by permission from the *British Med. Jour.*, June 8, 1935 p. 93 of *Epitome of Current Medical Literature*.)

As the result of long-continued investigation of different kinds of osteochondritis, the author claims that they are all local manifestations of the same pathological process and should no longer be classed as separate entities. Trauma is the most probable cause but does not produce the condition except in the presence of some other factor at present unknown. Radiographs supply evidence as regards the nature of the bone changes, the stage and possibly the age of the lesion, and the activity of the bone changes. In these conditions the bones become plastic and susceptible to deformity from pressure and strain. The clinical signs and symptoms usually disappear long before the plasticity, and treatment must therefore, be regulated by the radiographic appearances. Comparison of a series of radiographs taken at intervals during the course of the disease will supply the best evidence not only for regulating treatment but also for differentiating such conditions as sepsis, endocrine disorders, and chondrodystrophies which at one stage produce somewhat similar radiographic appearances.

CALCULI

The Etiology of Urinary Calculus H. P. Winsbury-White *British Jour. Urol.* June 1935 7, 103-115

To sum up briefly the author states that the trend of evidence is toward the fact that there are many factors which work in some cases individually and in others collectively to predispose toward urinary lithiasis. Whether these etiologic agents in due course give rise to a common lesion of the urinary tract or merely to changes in the urine which finally lead to stone are matters which still require elucidation. In the meantime the point of practical interest is that both prophylaxis and treatment can be profitably directed toward an endeavor to control known predisposing causes.

DAVIS H. PARDELL M.D.

CANCER (DIAGNOSIS)

Distribution of and Fight against Cancer Hans R. Schunz *Strahlentherapie* 1935 53, 363-416

In an abbreviated article of 53 pages (the complete original appeared in *Schweiz. med. Jahrbuch* 1935 p. 60) the well known Swiss radiologist discusses very thoroughly the fundamental principles of an intelligent fight against cancer. Backing all his statements with numerous statistical data, he concludes that we must wait patiently until the cause of cancer has been dis-

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High Speed Electrons and Their Significance in Radiation Therapy R Glocker *Strahlentherapie* 1935, 53, 417-423

The author studied the effect of high speed electrons produced in a specially constructed tube at 1.6 million volts on the eggs of *Drosophila*. It appeared that the percentage depth dose in a certain depth was higher than the surface dose in the extreme case as much higher as 50 per cent. This is in contrast to roentgen rays in which the dose in the depth is lower than the surface dose.

Glocker describes briefly an apparatus which is under construction and will be used in clinical tests for superficial therapy, it is supposed to operate at 2.5 million volts. He believes that the therapeutic use of high speed electrons is the method of the future and that the necessary equipment with potentials up to 20 million volts will soon be available.

ERNST A. POHLE M.D. Ph.D.

Radiation Genetic Experiments Dealing with the Time Factor on the Fruit Fly N. W. Timoféeff-Ressovsky and K. G. Zimmer *Strahlentherapie*, 1935, 53, 134-138

The authors studied the effect of the time factor on the rate of mutation in the fruit fly. They varied the intensity in the ratio of 1:300 and the total time of irradiation in the ratio of 1:1440. In both cases the exposure of 3000 r produced identical rates of mutation. It is concluded therefore, that the order of magnitude of the dose controls the rate of mutation and not the time factor.

ERNST A. POHLER M.D. Ph.D.

BONE DISEASES (DIAGNOSIS)

Multiple Spontaneous Idiopathic Symmetrical Fractures Louis A. Milkman *Am. Jour. Roentgenol. and Rad. Ther.* November 1934, 32, 622-634

The author reports a case followed over an eight year period with postmortem findings that he believes is a new skeletal disease which is progressive and may be fatal. The characteristics of this disease are the disturbance in gait, pains in the back, and involvement of the skeleton.

The characteristic roentgenographic appearance is bands or zones of increased transparency seen throughout the involved bones. They are multiple and symmetrical. The etiology is unknown. The parathyroid glands were not involved. Increased vascularity at the transparent zones was present suggesting trophic disturbance. The patient was 43 years of age when symptoms began.

S. M. ATKINS M.D.

Contribution Concerning Osteochondritis Dissecans P. Kroker *Röntgenpraxis* July 1935, 7, 455-460

Trauma and embolic processes are thought to be the cause for aseptic necrosis in the epiphyseal region of

several bones. Since Rahm has described a familiar occurrence of osteochondritis in six members of one family, the possibility must be considered that local causes are not the only bases for this disease. Some cases reported by the author seem to show that trauma is not necessarily an etiologic factor but that there must be a congenital inferiority of the skeletal system.

HANS W. HEFKE M.D.

Osteochondritis J. F. Brailsford *British Jour. Radiol.* February 1935, 8, 87-134 (Reprinted by permission from the *British Med. Jour.* June 8, 1935, p. 93 of *Epitome of Current Medical Literature*.)

As the result of long continued investigation of different kinds of osteochondritis, the author claims that they are all local manifestations of the same pathological process, and should no longer be classed as separate entities. Trauma is the most probable cause but does not produce the condition except in the presence of some other factor at present unknown. Radiographs supply evidence as regards the nature of the bone changes, the stage and possibly the age of the lesion and the activity of the bone changes. In these conditions the bones become plastic and susceptible to deformity from pressure and strain. The clinical signs and symptoms usually disappear long before the plasticity and treatment must therefore, be regulated by the radiographic appearances. Comparison of a series of radiographs taken at intervals during the course of the disease will supply the best evidence not only for regulating treatment but also for differentiating such conditions as sepsis, endocrine disorders and chondro-dystrophies which at one stage produce somewhat similar radiographic appearances.

CALCULI

The Etiology of Urinary Calculus H. P. Winsbury White *British Jour. Urol.* June 1935, 7, 103-115

To sum up briefly the author states that the trend of evidence is toward the fact that there are many factors which work in some cases individually and in others collectively to predispose toward urinary lithiasis. Whether these etiologic agents in due course give rise to a common lesion of the urinary tract or merely to changes in the urine which finally lead to stone are matters which still require elucidation. In the meantime the point of practical interest is that both prophylaxis and treatment can be profitably directed toward an endeavor to control known predisposing causes.

DAVIS H. PARDOLL M.D.

CANCER (DIAGNOSIS)

Distribution of and Fight against Cancer Hans R. Schinz *Strahlentherapie* 1935, 53, 363-416

In an abbreviated article of 53 pages (the complete original appeared in *Schweiz. med. Jahrbuch* 1935, p. 60) the well known Swiss radiologist discusses very thoroughly the fundamental principles of an intelligent fight against cancer. Backing all his statements with numerous statistical data, he concludes that we must wait patiently until the cause of cancer has been dis-

covered Until then surgeon and radiologist must co-operate closely in the treatment of malignant tumors This paper presents so much food for thought that a translation into English and publication at an early date is recommended

ERNST A POHLE M D, Ph D

Serial Bronchography in the Early Diagnosis of Bronchial Carcinoma Pedro L Fariñas Am Jour Roentgenol and Rad Ther December 1934 32, 757-762

In order to make a diagnosis of bronchogenic carcinoma in its early stages, serial bronchography under roentgenoscopic control is very important The polypoid type shows a filling defect *en face* and a notch in profile The infiltrating type produces concentric stenosis The necrotic type produces irregular bronchial cavities with diffuse borders

When the tumor is located near the large bronchi, it may compress and displace them, when very far away they displace the bronchioles and the parenchyma

S M ATKINS M D

CANCER (THERAPY)

Some Reflections Regarding Carcinoma of the Uterus with Special Consideration of the Technic in the Treatment of Infected and Febrile Forms Angelo Santoro d'Emidio Strahlentherapie 1935 53, 525-527

Carcinoma of the fundus, if operable, should go to the surgeon and if inoperable to the radiologist The author recommends intravaginal radium therapy by means of a pessary containing four radium screens This permits also the irradiation of the parametria The cervix is treated by means of a T-applicator containing two screens of 10 mg each filtered through 2 mm Pt In cases with extensive lesions, three screens are used The irradiation usually takes 11 days By using a special technic gauze packs are not required, which is, in the author's opinion very important A necrotic cervix is treated by continuous irrigation with Dakin solution External roentgen therapy is given either before or two months after the radium treatment regardless of whether or not the parametria are involved

ERNST A POHLE M D Ph D

Treatment of Cancer of the Penis K Overhof Röntgenpraxis July 1935 7, 468-472

The Clinic of Holfelder in Frankfurt reports 22 cases of cancer of the penis treated since 1926 Four cases were operated on and had post-operative irradiation their average length of life being from three to eight years, four cases were operated on only their duration of life being from one to five years, eight cases were treated with roentgen rays only the average length of life being from three to four years six cases were irradiated and later operated on the duration of life being from three to eight years The statistics offered by the author show that roentgen treatment alone offers about the same chance for the patient as

surgery, and that post-irradiation surgery may be done without harm when the tumor does not respond well to roentgen therapy If the cancer of the penis is removed surgically (with resection of the inguinal glands) prophylactic irradiation should always be employed

HANS W HEFKE, M D

CONTRAST MEDIA

Practical Observations on the Use of Iodized Oil in Bronchography L R Sante Am Jour Roentgenol and Rad Ther December, 1934 32, 763-768

Iodized oil injected into the trachea descends by gravity to the region of the smaller bronchioles only since the entrapped air in the terminal alveoli serves as a cushion Viscosity of the oil has no bearing on the ultimate filling The imprisoned air is then absorbed by the circulating blood and thus the oil reaches the alveoli

The application of cocaine to the bronchial mucosa defeats its own purpose since it causes dilatation and allows a much greater amount of oil to collect in the larger bronchial branches, which obscures the finer structures—in the early days of lung study they were mistaken for abscesses

The oil in the terminal air sacs remains unabsorbed for many months, when it loses its characteristic appearance and may resemble tuberculosis Owing to the possible fibrosis of the alveoli produced by this long sojourn it seems advisable to confine the examination to the immediate field under investigation and employ cocainization of the larynx only

The various methods of injection are mentioned the most satisfactory being through a catheter previously inserted into the trachea under local anesthesia since this permits roentgenoscopic observation during the injection

S M ATKINS M D

Historical and Practical Consideration of Pyelographic Media A E Goldstein and B S Abeshouse Am Jour Roentgenol and Rad Ther, February 1935 33 165-175 (Reprinted by permission of the British Med Jour June 8, 1935 p 93 of Epitome of Current Medical Literature.)

The authors compare various pyelographic media They consider that 'skiodan' in 15 or 20 per cent strength is the ideal medium for retrograde pyelography since a clear sharp outline of the upper urinary tract is always obtained and it is non toxic non irritating, and easy to inject It may be used for simultaneous bilateral pyelography with no danger of a post pyelographic reaction due to edema congestion or hemorrhage of the urinary mucosa Emulsified camptodol has also proved to be a good pyelographic medium since its use is almost painless The only objections to its employment are the difficulty of injecting it through a small ureteral catheter and its relatively high cost Sodium iodide (13.5 per cent) still retains its usefulness providing that the injections are made carefully and slowly Its low cost easy sterilization and low viscosity render it popular

The authors state that the frequent occurrence of unpleasant symptoms such as pain, burning, and hemorrhage, which follow its use, are due to the irritative and hemolytic action of the drug itself upon the urinary mucosa, even when no undue pressure has been exerted and over distention has been avoided. Since these untoward reactions may follow unilateral pyelography, its employment in bilateral pyelography is injudicious and dangerous. The fact that patients are frequently compelled to stay overnight in hospitals following a pyelographic study with sodium iodide thus increasing the cost of the examination is a further argument against its use.

DOSAGE

Comparison of the Roentgen and Radium Spectrum from the Standpoint of the Practical Radiation Therapist. R. R. Rathbone. *Am Jour Roentgenol and Rad Ther*, December 1934, 32, 808-809.

The dose received by the examiner can be minimized if the beam is kept as small as possible during roentgenoscopic examination, as the dose he receives is roughly proportional to the size of the beam used. This was proven by experiments performed with a wax model and ionization chamber measurements.

S. M. ATKINS, M. D.

Dosage in Radiation Therapy. R. Paterson. *British Jour Radiol*, March, 1935, 8, 155-162. (Reprinted by permission from the *British Med Jour*, June 8, 1935, p. 93 of *Epitome of Current Medical Literature*.)

The three basic physical factors in radiation dosimetry—quantity, quality (wave length), and time—are discussed. In x-ray work skin-dose measurement must include back scatter for the estimation of which the author recommends the phantom method. In radium therapy he thinks that the time has come to give up reckoning in milligram hours in favor of units of radiation since no gamma ray unit has yet received international acceptance though several have been described. So far in gamma ray therapy the measurement is made as in air, and factors of absorption and back scatter have not been considered but they appear to a large extent to compensate each other. Nevertheless as higher degrees of accuracy are sought, both these factors will have to be assessed more precisely. The quality in x-ray therapy can be stated in terms of a half value layer—copper, tin or aluminum all being used—while in radium therapy a sufficient description is given by a statement of the filtration for the question of the influence of wave length on biological effects is still very open.

An analysis of the relationship of the time factor to dose is according to Paterson probably one of the most important needs of radiological investigation. Considerable advantages would be gained if there could be some degree of standardization of the durations of exposure used particularly in each clinic by designating routine treatment times and arranging for all treatments

to approximate as closely as possible to them. Other problems awaiting elucidation include the explanation of the improved therapeutic results following prolongation of treatment time and the examination of the effects of intermittent exposure. There would appear to be much clinical evidence that the tolerance of tissue to fractionated dosage is greatest if treatment sessions are repeated as frequently as possible, and if each session is as long as possible, entailing the use of an intensity as low as can be economically provided. A certain amount of standardization of interval in relation to any one particular technic would help to yield valuable information.

ENCEPHALOGRAPHY

Technic and Diagnostic Evaluation of Encephalogram and Ventriculograms. B. Schlesinger. *Fortschr a d Geb d Röntgenstrahlen*, 1935, 51, 221-247.

A review of 52 consecutive cases of pneumographic cerebral investigation is presented, the evaluation of these cases being quite comparable to similar American reports. This method of investigation is considered valuable because of its positive and negative findings, the ascertaining of neurologic diagnoses, the furnishing of additional information in a number of cases, the correcting of some diagnoses, and particularly also of eliminating in a number of cases a clinical diagnosis of brain tumor. Such cases are reverted to neurologic diagnoses of, for instance, chronic encephalitis, meningitis, Little's disease, syphilis, arteriosclerosis, brain tubercles and multiple sclerosis.

H. A. JARRE, M. D.

THE ESOPHAGUS

Retrograde (Transgastric) Esophagoscopy for Carcinoma of the Esophagus. G. H. Steele. *British Med Jour*, July 13, 1935, 2, 63.

The author discusses the technic of retrograde transgastric insertion of radon seeds into the lower margin of carcinoma of the esophagus. Two cases in which this procedure was carried out are presented.

A very essential part of the procedure is the use of the gall bladder rest to raise the lower ribs. Under intratracheal anesthesia, the stomach is delivered through a left paramedian incision. After the application of a gastric clamp, a longitudinal incision about one and a half inches long is made in the anterior surface of the stomach. After the bleeding is controlled by the suture of the edges of the incision, the clamp is removed and applied across the stomach distal to the incision. The stomach contents are then removed by suction. The esophagoscope is then passed through the opening in the stomach and up into the esophagus, keeping the beak of the instrument close to the lesser curvature of the stomach to prevent it from slipping into the fundus. The radon seeds are inserted into the tumor mass by means of a Jobson's trocar and cannula. The esophagoscope is then withdrawn, the incision in the stomach is sutured, and the abdomen closed.

It is believed by the author that with the use of this method the combined irradiation of the tumor mass from above and below is preferable to the haphazard irradiation when only the upper edge of the mass is irradiated. Deep x-ray therapy should be employed before the insertion of the radon seeds in order to thoroughly irradiate the peri-esophageal field.

J N ANÉ M D

GALL BLADDER (NORMAL AND PATHOLOGIC)

Diseases of the Gall Bladder Cecil P G Wakeley
British Med Jour Aug 10 1935 2 243-246

The author discusses the diseases of the gall bladder under the following headings: absence, double gall bladder, torsion, traumatic lesions, cholecystitis and malignant disease of the gall bladder.

The gall bladder is rarely absent in man. It develops from the primary hepatic diverticulum and when this outgrowth is bifid, double gall bladder or subdivision of the fundus occurs. This anomaly is rather rare; for Graham was not able to find a single example in 1,218 cases examined by cholecystography. Cave reported two cases which were discovered by means of cholecystography.

During embryonic life the gall bladder is embedded in the substance of the liver and this condition may persist throughout life in some individuals. On the other hand the opposite condition of a freely mobile gall bladder may be found in some cases. In from 4 to 8 per cent of gall bladders a well formed mesentery is usually found. However the great majority of these gall bladders are not free because of adhesions to the omentum or the duodenum. It is believed that partial rotation of the organ takes place in most cases, which results in congestion and even inflammation and eventually the formation of adhesions between the gall bladder and surrounding structures. An abnormally long cystic duct likewise predisposes to torsion. Torsion of the gall bladder results in a history of pain in the right abdomen. The surgical treatment of this condition is not so difficult because of the mobility of the gall bladder.

Rupture of the gall bladder with escape of bile into the peritoneal cavity results in acute peritonitis whether organisms are present or not. In the case of gradual escape of bile into the peritoneal cavity a localized intraperitoneal abscess occurs. Jaundice is noted as the result of the absorption of the bile by the peritoneal cavity. The treatment of this condition is exploratory laparotomy after the initial shock has passed off.

The inflammatory lesions of the gall bladder may be divided into acute and chronic cholecystitis. The author believes that while all perforations of the gall bladder should be operated upon immediately that in acute cholecystitis conservative surgery should be the treatment of choice. The patient should be observed very closely and conservative measures instituted. If it is noted that the patient's condition does not improve operation should be performed. In any case it is

always advisable to remove the gall bladder after the acute attack of cholecystitis has subsided and the author considers one month after the disappearance of all symptoms as the useful time to allow before operation.

In the case of chronic cholecystitis the author believes that the treatment should be complete removal of the gall bladder. While he believes that medical treatment and diet will do a certain amount of good he does not believe that these forms of therapy can cure the condition or prevent complications. Cholecystography can be of great value in the diagnosis of organic disease of the gall bladder but it only indicates its power of concentration. A preliminary film should always be made before cholecystography to demonstrate calcified gallstones if these are present.

Carcinoma of the gall bladder is a rare disease but would be even rarer if cases of chronic cholecystitis were submitted to operation. In fully 95 per cent of cases of malignant gall bladders, calculi were found and in the author's series of ten cases of carcinoma of the gall bladder calculi were found in every case.

J N ANÉ M D

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Roentgenkymography of the Duodenal Bulb S L Sorkin Fortschr a d Geb d Röntgenstrahlen 1935 51, 35-38

The author presents the following points:

1. Pyloric opening is produced by gastric systole closure by gastric peristalsis.
2. Evacuation of the duodenal bulb takes place in two phases: a quick initial systolic emptying followed by a slow concentric contraction of all wall segments.
3. There always remains a small residue in the bulb.
4. Further transportation is accomplished by peristaltic action in the more distal duodenal segments.
5. Frequency of the duodenal bulb is half that of gastric peristalsis and concurrent with each pyloric closure.

H A JARRE M D

Unusual Roentgen Observations in Achylia Chloranemia R Pape Fortschr a d Geb d Röntgenstrahlen 1935 51, 39-46

In 1929 the syndrome of achylia chloranemia was described by Kaznelson, Reimann and Weiner. This disease much resembling pernicious anemia occurs in women beyond middle age with anemia, weakness, loss of appetite, burning of the tongue, diarrhea, fragility and deformity of the nails, occasionally paresthesias and rarely funicular symptoms. The color index in contrast to p.p.a. is reduced. Gastric secretion is reduced and there is in well established cases a complete achylia not responding to histamine but with preservation of the anti p.p.a. principle. The disease develops frequently on the basis of preceding gastric organic disease and following gastric operations. It responds very well to iron therapy.

Three cases of the disease are reported which showed

unusual roentgen symptoms In one case a diffuse chronic hyperplastic gastritis of severe degree was observed In two patients who had undergone previous gastric surgery, 'pseudo-defects' liable to misinterpretations were noted which are explained as localized coarse piling up of mucosal folds in the presence of perigastric adhesions All three cases gave a history of previous ulcer, present symptoms of occult melena severe anemia, gastric distress changes in nails etc as mentioned above 'Pseudo defects' should be differentiated from malignancies by circumscribed more clear-cut delineation lack of symptoms of decay lack of circular involvement, and disappearance on careful palpatory exploration

H A JARRE, M D

Roentgenologic Recognition and Evaluation of Intestinal Anastomoses E A Zimmer Fortschr a d Geb d Röntgenstrahlen 1935 51, 169-180

The end-to-end anastomosis is superior to the end-to-side or the side-to-side junction Resection of part of the sigmoid is advocated in cases of chronic incurable constipation

Quite a few of the physiologic remarks of this paper are debatable

H A JARRE M D

Congenital Malformation of the Large Bowel John Alexander Mackenzie British Med Jour July 13 1935 2 61

The author reports a case of non rotation of the colon, in which the only complaint was a dull dragging pain in the right side As a child the patient had had a good deal of diarrhea The radiologic examination revealed that the barium meal passed from the stomach to the right side of the pelvis The cecum was found on the left side of the pelvis

This case is explained embryologically by a study of the normal development of the colon The fore gut is supplied by the celiac axis the mid gut by the superior mesenteric and the hind gut by the inferior mesenteric artery A physiologic umbilical hernia results because of the increase in the length of the mid gut The attachment of the vitelline duct and artery to the apex of the loop produced by the mid gut divides the mid gut into a pre arterial and a post arterial segment Rotation begins about the tenth week and the contents of the hernial sac return in stages The pre arterial segment returns to the abdominal cavity first and passes under the superior mesenteric artery which extends from the aorta to the umbilicus The cecum is the last segment of the bowel to be returned to the abdominal cavity It comes to lie in the region of the umbilicus anterior to the small intestine and superior mesenteric artery The increase in length of the colon causes the cecum to pass to the right, in front of the small intestine and superior mesenteric artery and then descends to lie in the ileo-cecal fossa In the case of non rotation the

cecum and post-arterial segment return to the abdomen before the pre arterial segment

J N ANÉ, M D

Roentgenkymograms of Gastric Ulcer and Gastric Motor Function C Schilling Fortschr a d Geb d Röntgenstrahlen, 1935 51, 29-35

A kymographic analysis of normal gastric mobility leads to the consideration of active peristalsis, passive motor phenomena of the proximal gastric segments and systolic contractions of the entire viscus In cases of anatomic pathology one can observe, as direct disturbance of function local arrest of motion and interruption of peristalsis, as indirect symptoms, altered peristalsis and differences in tone and filling of the organ Various locations of anatomic lesions produce a wide variety in functional disturbances which can be studied to considerable advantage by the use of the kymograph

H A JARRE M D

GENITO-URINARY TRACT (DIAGNOSIS)

The Value of the Urea-clearance Test in Urinary Surgery E W Riches British Jour Surg July, 1935 23, 128-140

The urea-clearance test is discussed and the technique employed is described The results of the test in 109 surgical cases are tabulated The presence of urinary infection lowers the clearance value The test is reliable as an index of operability in prostatic obstruction in cases in which the urea-clearance is over 60 per cent operation is safe whilst below this figure it is hazardous

In unilateral lesions of the upper urinary tract, the total renal function is of little importance, it improves after removal of the underlying cause, and a normal urea-clearance may be attained with only one kidney

DAVIS H PARDOLL M D

GENITO-URINARY TRACT (THERAPY)

Necessity for Both Excretory and Retrograde Urography in Certain Cases Daniel N Eisendrath British Jour Urol June 1935 7, 124-139

In three cases a comparison could be made between the information obtained respectively by excretory and ascending (retrograde) urography In the first case the latter method visualized the right renal calices showed the size of the hydronephrosis and its probable cause whereas excretory urography only enabled the diagnosis to be made that a hydronephrosis was present and that there was marked muscular atony Visualization of the calices in this Case 1 was deemed necessary to exclude tuberculosis

In the second case the excretory method visualized the renal pelvis on both sides but not the left calices It yielded valuable information as to the presence of a left hydronephrosis It failed however to be of aid in determining the character of a shadow thought to be

a renal calculus and its position in the kidney Ascending urography gave all of the missing evidence as to the calculus and a far better conception of the size of the hydronephrosis and of its etiology, as being due to acquired kinking of the ureter

In the third case, excretory urography failed to show the left hydronephrosis owing to absence of elimination of the opaque medium on this side Ascending urography enabled the author to detect the presence of a large hydronephrosis due to a ureteral stricture of traumatic origin The absence of sufficient parenchyma to eliminate the intravenously given opaque medium probably explains why it was not eliminated on the left (hydronephrotic) side, yet gave a good shadow on the normal opposite one

In the fourth case of multiple infarcts of the kidney (of hematogenous origin in all probability), only excretory urography was employed to ascertain whether or not the patient had an opposite kidney and also to acquire some information as to its function before operation on the right kidney

Absolute failure to eliminate not only the opaque medium but also indigo carmine, both given intravenously can best be explained by a right sided transitory anuria due to inhibitory nerve influence on renal secretion as the result of the intense hyperemia incidental to the septic infarcts A similar absence of elimination after excretory urography may be observed in normal kidneys in those extensively destroyed by disease and in acute ureteral occlusion as well as in acute hyperemia due to acute renal infection as in Case 4

DAVIS H PARDOLL, M D

Epididymal Cysts Their Etiology and Treatment E D'Arcy McCrea British Jour Urology June 1935 7, 152-155

The author finds that the common epididymal cysts are retention cysts resulting from obstruction The treatment of choice is by epididymectomy which completely removes the weak links in the seminal tract

DAVIS H PARDOLL, M D

Posterior Segmental Block-excision of the Bladder Neck with Primary Closure S Harry Harris British Jour Surg July 1935 23, 45-50

A new operation is described for the treatment of obstructive disease of the bladder neck in which there is no gross enlargement of the prostate It may be regarded as a companion to the author's operation of suprapubic prostatectomy with closure It has been carried out 33 times without mortality

The operation described eliminates the liability to recurrence of obstruction which characterizes cuneiform resection In addition the operation is less extensive and safer than complete extirpation of the bladder neck (ablation totale du col" of Marion) and should ensure results at least comparable with those claimed for this operation

The diseases for the treatment of which this operation has been designed will often be treated by per urethral resection, though with what degree of permanence yet remains to be proved

The type of operation selected should be determined not only by the particular local obstructive condition of the bladder neck but also by the incidence of such complications as stone and diverticulum of the bladder

The article is accompanied by several reproductions on the technic of this block-excision described by the author

DAVIS H PARDOLL, M D

GYNECOLOGY

Short Wave Radiation in Rectal and Vaginal Conditions M Delherm and Mme Fausilber Rev d Actinol et de Physiothér, March-April, 1935 11, 115-120 (Reprinted by permission from British Med Jour July 27, 1935 p 15 Epitome of Current Medical Literature)

The authors review the possibilities of treatment by short waves of conditions of the rectum and vagina and record illustrative cases They have thus successfully cleared up cases of vaginitis metritis perimetritis inflammations of the adnexa such anal affections as essential fissure, pruritus with ulceration and sphincter pain associated with hemorrhoids or perianal ulceration In these painful and sometimes very resistant conditions the intrarectal administration of short wave therapy has resulted in quick amelioration High frequency currents or diathermy or the two combined, often act in a similarly prompt and effective fashion but in the syndromes including sphincter pain a smaller number of sessions are required when short waves are employed Short wave therapy proved particularly valuable in cutaneous perianal ulcerations and anal pruritus operating well also in the latter at a distance as well as intrarectally In some cases reported by the authors associated treatment by cauterizing or sclerosing medication seemed to hasten cure in others the short wave treatment acted promptly without such measures of reinforcement The number of sessions required was variable but it was found that the best and most lasting results were obtainable when the total exceeded eight and the treatment was continued even after the cessation of symptoms

HEART AND VASCULAR SYSTEM

The Pulsatory Excursions of the Thoracic Aorta G A Weltz Fortschr d Geb d Röntgenstrahlen 1935 51, 152-169

It is concluded from kymographic studies that excursions of the descending aorta consist chiefly of shifting movements while there is but little evidence of a peristalsis like effect so that the latter can hardly be

detected fluoroscopically The amplitude of these excursions is increased by high position of the diaphragm freedom of motion wide amplitude of blood pressure It is reduced in cases of sclerosis and marked diffuse aortic widening There is but little resemblance between the curves of blood pressure and the excursion of the left-sided aorta except that the maximum of both is coincident in time

Movements of the *right sided* aorta represent a summation of intrinsically aortic and indirect transmitted ventricular factors which cannot be demonstrated individually Only from a shifting of the curve of the ascending aorta to the left as compared to that of the descending segment can one infer as to the preponderance of aortic or ventricular influences The latter is magnified by high position of the diaphragm cardiac enlargements with increased ventricular amplitude large sub sternal goiters elongation and tortuosity of the aorta without widening It is reduced as a result of small ventricular amplitude and marked aortic widening The ventricular influence on the ascending aorta is exerted at the end of ventricular filling and during the period of increasing tonus, not during evacuation

H A JARRE, M D

The Diagnostic Significance of Kymographically Registered Aortic Pulsations A Kahlstorf and E Ohnesorge Fortschr a d Geb d Röntgenstrahlen, 1935 51, 22-29

Kymograms show characteristic differences in the excursion of the aortic wall especially in the ascending segment so that aortic insufficiency mesaortitis luetica, sclerosis and hypertonia may be differentiated Extensive thrombosis can at times suppress all pulsation of aneurysms, consequently a differential diagnosis between such and mediastinal tumor may become impossible Sclerosis and hypertonia which often show reduced excursion of the walls also may be confusing All differences in excursion gradually fade out in the descending aorta

H A JARRE M D

THE LUNGS

Fibrin Bodies in the Pleural Cavity with Report of Three Cases Arnold Shamaskin and Jacob Rogoff Am Jour Roentgenol and Rad Ther November 1934 32, 613-616

Fibrin bodies in the pleural space may be found in cases of hydropneumothorax and become visible when the fluid level drops These bodies have no significance They may be free or attached to the pleural surface Usually they disappear but may persist and eventually calcify Their average size is that of an English walnut and they usually present a homogeneous density with a smooth sharp outline Their only importance is the danger of confusion with neoplasms encysted empyema costosis of a rib and foreign body

S M ATKINS M D

Studies of the Value of Fluoroscopic Examination of the Lungs Wolf Voigtländer Röntgenpraxis July, 1935, 7, 433-439

Quite a few studies have been undertaken to determine the comparative value of film and fluoroscopy for the diagnosis of tuberculosis of the lungs Each type of examination has advantages and both of them should be used If fluoroscopy alone is used about 20 per cent of the positive cases will not be recognized, especially the disseminated small nodular type apical processes and small infiltrates (Redeker, Braeuning, Engelhardt, and others)

One hundred and eighteen patients with tuberculosis were examined fluoroscopically by the author, who had neither examined the patients clinically nor seen their roentgenograms, of these, 67.8 per cent were diagnosed correctly by the fluoroscopic examination, in 32.2 per cent the fluoroscopy did not give a correct diagnosis The result of the fluoroscopic observation was afterward compared with films These 32 per cent of incorrect or insufficient diagnoses prove that fluoroscopy alone cannot be considered a reliable diagnostic means for examination of the lungs

HANS W HEFKE M D

A Contribution to the Roentgenologic Demonstration of Emphysema of the Lungs A Anthony and W Schwarz Röntgenpraxis July 1935, 7, 461-463

For the roentgenologic demonstration of emphysema the authors have used roentgenograms in inspiration and expiration While normally there is a definite difference between the two roentgenograms, consisting of lessening in the size of the thorax, elevation of the diaphragms, change in position and size of the heart, disappearance of the lower portion of the heart into the shadow of the diaphragms and increase of the lung markings seen on expiration, patients with emphysema show an entirely different picture Most of the above changes were either not present at all in the authors' cases or very slight Although this method cannot be very accurate it allows a visual demonstration of emphysema of the lungs

HANS W HEFKE, M D

The Roentgen Appearance of the Lobulus Accessorius J S Bejlin Fortschr a d Geb d Röntgenstrahlen 1935 51, 47-61

The lobulus accessorius or infracardiacus known since Rectorzik in 1861 and described in detail by Schaffner and Muller forms a pyramidal pulmonary segment on the basal medial area of the normal lower lobes Its occurrence is not as rare as usually assumed, though statistical data vary widely, as do also its size and configuration Localized acute and chronic infections in this lobe render its roentgen recognition relatively easy Chronic lobitis at times with bronchiec-

tases, is at times responsible for so-called triangular basal and paramediastinal shadows

H A JARRE, M D

NERVOUS SYSTEM

Possible Effects of Roentgen and Radium Rays on the Vegetative Nervous System M Nemenow *Strahlentherapie*, 1935, 53, 473-491

The author analyzes the mechanism of the various effects observed following roentgen exposure of the autonomic nervous system. The fact that the HCl content of the stomach, its tonus and peristalsis, as well as the blood sugar may be increased or decreased following irradiation can be explained by the assumption that the nerves in a state of higher excitability respond to irradiation. This means that in one case the accelerated fibers will be affected and in the other case the inhibitive fibers. A few patients with stomach ulcer are discussed, who showed remarkable improvement following roentgen therapy. Roentgenograms of the stomach before and after treatment are appended. Experimentally the author could also demonstrate a definite influence of irradiation of the medulla oblongata on the respiration in the decapitated cat.

ERNST A POHLE, M D, Ph D

The Effect of Roentgen Therapy on the Vegetative Nervous System Heinz Langer *Strahlentherapie*, 1935, 53, 492-522

The author explains the effect of roentgen rays in asthma, climacteric disturbances, arthritis, neuralgia, thyrotoxicosis, and vasomotor disturbances by the effect of roentgen rays on an overstimulated vegetative nervous system. He distinguishes two stages of the reaction following treatment: Stage I of an increased excitability and Stage II of lessened excitability. He also believes that unless these two stages of reaction occur there will be no clinical response. The technique used is described in detail in two articles published in English (*Am Jour Roentgenol and Rad Ther* 1932, 28, 747 and *RADIOLOGY* 1933, 20, 78).

ERNST A POHLE, M D, Ph D

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Radiation Therapy of Neuralgia A Zimmermann, P Cottenot and J A Chavany *Strahlentherapie* 1935, 53, 523-524

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In any case, the immediate future calls for: (1) More radium (3 gm is a necessity, 4 gm ought to be forthcoming and much more is desirable); (2) improvements of bomb apparatus; (3) further exploration for means for measuring the dose; (4) accumulation of data as to effective dose in the relation to tumors of different organs and of different histological types; (5) agreement as to grouping of clinical cases—this should be international; (6) more universal co-operation with physicists; (7) transference of control of both forms of apparatus to the same hands—those of the radiologists.

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G E BURCH, JR., M D

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THE EFFECTS OF THORIUM DIOXIDE SOL (THOROTRAST)¹ ON THE HUMAN LIVER²

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Prepared with the aid of a grant from the Medical Research Fund of the Graduate School of the
University of Minnesota

INTRODUCTION

THE usefulness of thorium dioxide sol in the roentgen diagnosis of diseases of the liver and spleen has been well demonstrated by numerous articles in the recent medical literature (23, 24, 15, 16, 7, 33, 13). Its utility, however, has been greatly restricted by the fear, which has been so frequently expressed, that ill effects may follow its injection. The dangers associated with the use of this substance have been abundantly described and numerous conflicting opinions have been presented regarding the justification for its employment. While the original protagonists for the utilization of this colloidal suspension of thorium dioxide (thorotrast), Radt (24) and Kadrnka (16), apparently are satisfied that it presents no real danger, others, such as Anders and Leitner (1), Buchner (2), Cooke (4), Hanke (8), Shute and Davis (29), Pohle and Ritchie (21) and others, criticize the use of this material most emphatically. Naegeli and Lauche (20) take a middle ground, while numerous other

authors, such as Ravenna (26), Tripoli (30), Tripoli, Haam and Lehman (32), Irwin (14), Yater and Otell (33), Erickson and Rigler (7), Hirsch and Morton (13), and others believe there is relatively little harm produced by this procedure, if the opaque substance is given in moderate doses.

The dangers inherent in this method of roentgen diagnosis may be divided into a number of categories. There are, first, the usual accompaniments to the intravenous injection of any substance, particularly a colloid. The immediate effects, such as rise in temperature, slight nausea, flushing, etc., have been previously described (7) and are of no particular consequence. The hemoclastic effect of the injection of colloids has been emphasized by Shih and Jung (28). Our experience, and that of many others, would seem to indicate that these hemoclastic crises, which Stewart, Einhorn, and Illick (27) encountered, are due either to unstable or poorly prepared material or to the use of enormous doses. As stated in a previous publication (7), we have had only one such experience and this was later proved to be due to a faulty preparation. One case of death from anuria—a possible sequence to injection of a colloid—has been reported (34), but in this case a transfusion

¹ The preparation used in this work was the commercial product Thorotrast made by the Heyden Chemical Corporation.

² Presented as an exhibit at the Twentieth Annual Meeting of the Radiological Society of North America at Memphis Tenn. Dec. 3-7, 1934.

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In any case the immediate future calls for: (1) More radium (3 grm is a necessity, 4 grm ought to be forthcoming and much more is desirable), (2) improvements of bomb apparatus, (3) further exploration for means for measuring the dose, (4) accumulation of data as to effective dose in the relation to tumors of different organs and of different histological types, (5) agreement as to grouping of clinical cases—this should be international, (6) more universal co-operation with physicists, (7) transference of control of both forms of apparatus to the same hands—those of the radiologists.

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can hardly be considered a controlling force in the judgment of the dangers of this substance when given in reasonable amounts. On the other hand, definite changes have been reported (10, 19, 21) in animals even with doses as small as one and one-half to three times the normal. While the regenerative powers of the human liver are well known, nevertheless, one hesitates to produce any damage merely for purposes of diagnosis. It is these two factors particularly, *i e*, the lack of elimination of the material and the production of necrosis, cloudy swelling, and atrophy in the liver, spleen, and lymph nodes, which have prevented the widespread utilization of this method of roentgen diagnosis.

Because there are differences in the behavior of animals and man toward such substances, and because in experimental work larger doses than normal have been used, we have felt that a careful study of clinical cases would add to our knowledge of the dangers of the employment of thorium dioxide sol to render the liver and spleen opaque to roentgen rays.

Relatively few studies have been made on the liver of humans after the injection of this material. Whitaker, Davie, and Murgatroyd (35) reported on three cases examined postmortem. Tripoli (30), Hirsch and Morton (13), Ericksen and Rigler (7), Kadrnka (16), Popper and Klein (22), Randerath (25), and others have also reported the evidences of histologic changes as observed at autopsy. In none of these reports has there been any alarming evidences such as have been observed in animals by Shute and Davis (29), Cooke (4), Pohle and Ritchie (21), and others, although some definite changes were demonstrated.

CLINICAL STUDIES

We have had the opportunity of examining 175 patients with thorium dioxide sol in the past three and one-half years. The first 80 cases in this series have already been reported (7), and the present report is intended to demonstrate, insofar as possible,

the eventual results which could be observed in these patients.

The type of case which was subjected to this examination is indicated in Table I. It should be noted that the patients were almost all suffering from very grave diseases, largely malignant tumors, with or without known metastases. The high incidence of liver metastases, found on roentgen examination by this method, is shown.

TABLE I—TYPE OF CASE IN WHICH THORIUM DIOXIDE SOL (THOROTRAST) EXAMINATION WAS USED AND INCIDENCE OF POSITIVE FINDINGS

Primary Diagnosis	No of cases	Hepatolienography	
		Positive	Negative
Carcinoma of stomach	80	17	43
Carcinoma of colon	15	4	11
Carcinoma of rectum	21	10	11
Carcinoma of breast	12	6	6
Carcinoma, miscellaneous	27	14	13
Malignant tumors miscellaneous	9	1	8
Leukemia	2	2	0
Lymphogranuloma	4	2	2
Actinomycosis	2	1	1
Cirrhosis of liver	5	4	1
Miscellaneous diseases	18	5	13
Total	175	66	109

In Table II, the diagnostic accuracy of this procedure, as demonstrated by surgical or postmortem exploration, is tabulated. In spite of a relative lack of experience with the method it can be noted that the accuracy is relatively high. The three positive errors were all due to misinterpretation of normal structures, such as the vascular channels of the liver, the gall-bladder fossa, and the areas of apparently lessened density between the anterior ribs. The negative errors are really not as frequent as appears from the table. In two cases, for example, the carcinomatous metastases were microscopic in size and could not be detected even at autopsy by gross examination. In another case only one very small metastasis was found, while in still another only two small nodules were present. From the diagnostic standpoint, our experience on the whole was very satisfactory.

The present status of the patients to whom thorium dioxide sol was given may also best be demonstrated in tabular form.

had also been given, so there is serious doubt as to the culpability of the thorium preparation. Some transient anuria, however, has occurred in dogs after the injection of thorium dioxide sol. We have had no such experience either in animals or amongst the 175 patients upon whom we are here reporting.

The possibility of rupture of the spleen has been considered because of the report of Bungeler and Krautweig (3), who gave a fairly large dose of thorium dioxide sol to a patient with severe reticulo-endotheliosis. A massively enlarged, very soft spleen was present and rupture occurred, with a fatality resulting. They consider massive enlargements of the spleen and reticulo-endotheliosis contra-indications to the use of this method.

The production of a partial or complete obstruction of the reticulo-endothelial system by the introduction of colloidal material has been frequently considered one of the objections to the use of thorium dioxide sol. It has been repeatedly demonstrated, however, that blockage of these phagocytic cells is virtually impossible. Furthermore, it has been shown that the function of these cells is so selective that they will continue to phagocytose foreign substances of a different type, even though they have already ingested large amounts of another substance. The experiments of Ravenna (26) indicate clearly that the normal function of the reticulo-endothelial cells of the liver is maintained in spite of the introduction of large quantities of colloidal thorium. Held (12) was unable to demonstrate any definite change in the immunity of animals after injection of this substance.

None of the preceding deleterious effects are sufficiently frequent or of any great importance in the consideration of the general use of thorium dioxide sol for the roentgen examination of the liver and spleen. Of much greater importance is the fact, now generally admitted, that elimination of this substance from the liver and spleen, if it occurs at all, is exceedingly slow, the material remaining in the body at least for many years. Some evidence of the nature

of this slight elimination has been advanced by Kadrnka (16), Naegeli and Lauche Leipert (17), and others. The introduction of a foreign body of this nature, which remains permanently in the body, is fraught with danger to the organ in which it is deposited. It may produce tissue changes as a result either of a specific toxic effect, of a simple foreign body reaction, or from the slight radio-activity which it possesses.

The matter of the radio-activity of this substance was originally a source of concern (5, 7), but of late this has not been stressed to any great extent. The dose has been reduced—we are now using 0.6 c.c. of the commercial preparation, thorotrast (Heyden) per kilo of body weight—to a point at which the total minimum radio-activity appears to be well below the usually accepted tolerance quantity. In an experience of over four one-half years, no effects which could definitely be assigned to the radiations of thorium have as yet been reported. It has been pointed out that it is barely possible that the histologic changes observed in the liver, spleen, and lymph nodes may be related to the alpha particles given off by the decay of the various components of this colloidal suspension, but this conclusion seems highly improbable. The nature of the changes is not at all that of radiation necrosis (9), and there are none of the other effects which might be expected. Obviously, it will be impossible to settle this point until observations have been continued for a longer period of years, and the present this question must be left abeyance.

By far the most important deleterious effect which has been reported is concern with the histologic changes which occur in the liver, spleen, and lymph nodes. These have been observed chiefly in experimental animals and, in large part, unfortunately after the introduction of very large or massive doses. The demonstration of severe disintegration of the liver after the injection of a dose approximately ten times the normal, while it may be of importance in determining the limitations of the dosage

ciently recovered to have the tube removed. Her condition has greatly improved in the interval and there is not the slightest evidence to indicate any harmful effects from the colloid which she received.

A case of extensive carcinoma of the stomach was subjected to hepatolienography and no metastases were found in the liver. A radical gastric resection was done from which there was an uneventful recovery. This patient was seen over two years later and apparently is still perfectly well.

These cases illustrate the recuperative power of patients who have been subjected to roentgen examination with thorium dioxide sol and indicate the absence of any impairment of their resistance.

In the entire series of 175 cases only two serious reactions occurred. The first, a hemoclastic crisis, has already been reported (7). The second, in which there was a severe chill, was probably due to an intravenous injection of glucose solution which followed the instillation of the thorium suspension. The character of the reaction was typical of that occurring occasionally with glucose injections.

A number of cases have had liver function tests done at various intervals following the introduction of the colloid and no evidence of any impairment has been adduced. There has never been any particular evidence of anemia, blood destruction, or other changes. In no instance have we been able to observe any late deleterious effects upon these patients which could fairly be assigned to the use of this material.

HISTOLOGICAL STUDIES

In this group of cases some 35 individuals have come to autopsy under our supervision. All of these have died of carcinoma or its consequences, three of them being cases of primary carcinoma of the liver. On histologic study the thorium dioxide was found widely distributed throughout the body, very small amounts being demonstrable in the lymph nodes, bone marrow, adrenals, testes, and lungs, in ad-

dition to large amounts in the liver and spleen.

It should be noted that the carcinomatous areas in the liver contained no thorium granules with the exception of one case of primary carcinoma of the liver. In this tumor, the thorium was present in large amounts in the abnormal tissue. Whether this was due to the infiltrating character of the malignancy which made it difficult to distinguish the normal from the abnormal cells, or whether the carcinomatous cells retained their normal function of phagocytosis, was not finally determined. The possibility that certain types of primary hepatoma reproduce histiocytic cells, which continue to function normally, must be strongly considered.

In such a group of patients one always expects such terminal changes as cloudy swelling, fatty replacement, and passive congestion in the liver. In this series, cloudy swelling was frequent, passive congestion was present in eight cases, fatty metamorphosis in three, and leukocytic infiltration in one. In this latter case there was a peritonitis which no doubt occasioned this finding. It was impossible to correlate the position of the thorium granules with the points of maximum change except in the cases of chronic passive congestion. In these cases there are definite areas of atrophy which are commonly found with passive congestion. It is notable that there was a very definite concentration of the thorium in the areas of atrophy. This is consistent with the experimental work of Ravenna (26), indicating the viability and normal function of the reticulo-endothelial cells which continue to migrate to points of injury in spite of the presence of thorium within them. No correlation could be observed between the histologic changes and the length of time following the introduction of the thorium dioxide sol, although cases were examined at intervals of from a few days to nine months after the examination.

The histologic appearance of the human liver containing thorium dioxide is illustrated in Figure 1. This is a low power

TABLE II —DIAGNOSTIC ACCURACY OF HEPATOLIENOGRAPHY

Proved cases	74	Correct 65	Incorrect 9
By autopsy	35		
By operation	39		
Roentgen diagnosis positive		Correct 16	Incorrect 3
Roentgen diagnosis negative		Correct 49	Incorrect 6

(Table III) As might be expected, the vast majority have succumbed. Many of them were almost moribund at the time of the injection. Many underwent very radical resections of the stomach, colon, or rectum and did not survive the surgical procedure. Many already had extensive metastases at the time of the examination or developed them shortly after. It is our well-considered judgment that the mortality in this group is no greater than would ordinarily be expected with this type of patient (Table I). In support of this it may be observed that most of the patients with relatively minor diseases such as cholelithiasis, enlarged spleen of undetermined origin, or intra-abdominal masses of benign nature, to whom this material was given, either in error or in the earliest period of our experience, are still living and well.

TABLE III —EVENTUAL OUTCOME OF 175 PATIENTS RECEIVING THORIUM DIOXIDE SOL (THOROTRAST)

Known living and apparently unaffected	43
Cases followed less than 12 months	15
Cases followed less than 18 months	5
Cases followed less than 24 months	11
Cases followed less than 30 months	8
Cases followed less than 36 months	2
Cases followed less than 42 months	2
Known dead (all had malignant tumors or other grave disease)	100
Unable to trace (many undoubtedly still living)	32

Several outstanding examples amongst the living patients should be noted. The longest period during which one individual has been observed is now three and one-half years (Fig 8). This patient has had a serious surgical procedure for relief of a strangulated hernia, and again for intestinal adhesions since this injection of thorium dioxide, and has survived both operations without difficulty. Careful studies 41 months after the injection showed no evidence of impairment of liver function, of anemia or blood changes, or any other find-

ings which could possibly be traced to the procedure of hepatolienography.

Another case is sufficiently interesting to report in detail. The patient, a female, was first seen approximately two and one-half years ago with an extensive carcinoma of the breast. Following the introduction of thorium dioxide sol and the roentgen examination of the liver and spleen with a negative result, resection of the breast was done. Within two months carcinomatous metastases to one lung could be demonstrated. In spite of this she has survived two and one-half years while the lung tumor has slowly increased in size.

Other striking instances may be cited. In one case of carcinoma of the breast (Fig 7) there were extensive metastases to the spine at the time of the examination. Hepatolienography showed no evidence of metastasis to the liver. With the use of radiation therapy this patient has survived over two years, showing no evidences whatever of deleterious effects from the thorium preparation. Another patient with a carcinomatous ulcer of the stomach, so high that it was not considered resectable, is still living, two years since the hepatolienography was done. The carcinoma has been increasing very slowly in size. A patient with extensive actinomycosis of the lung, on physical examination, appeared to have an enlarged liver. As an extensive surgical procedure was planned in an effort to extirpate the diseased lung, it was thought advisable to examine her liver for possible actinomycotic abscesses. None were found and a partial resection of the lower lobe of the lung was performed by Dr O H Wangersteen. The patient survived several other surgical procedures, eventually succumbing from a brain abscess two and one-half years after the procedure of hepatolienography was undertaken.

In another case, one of unexplained jaundice, thorium dioxide sol was introduced to determine the condition of the liver. Surgical exploration was undertaken later and a permanent drainage tube was inserted into the common duct. Almost three years have elapsed and the patient has suffi-

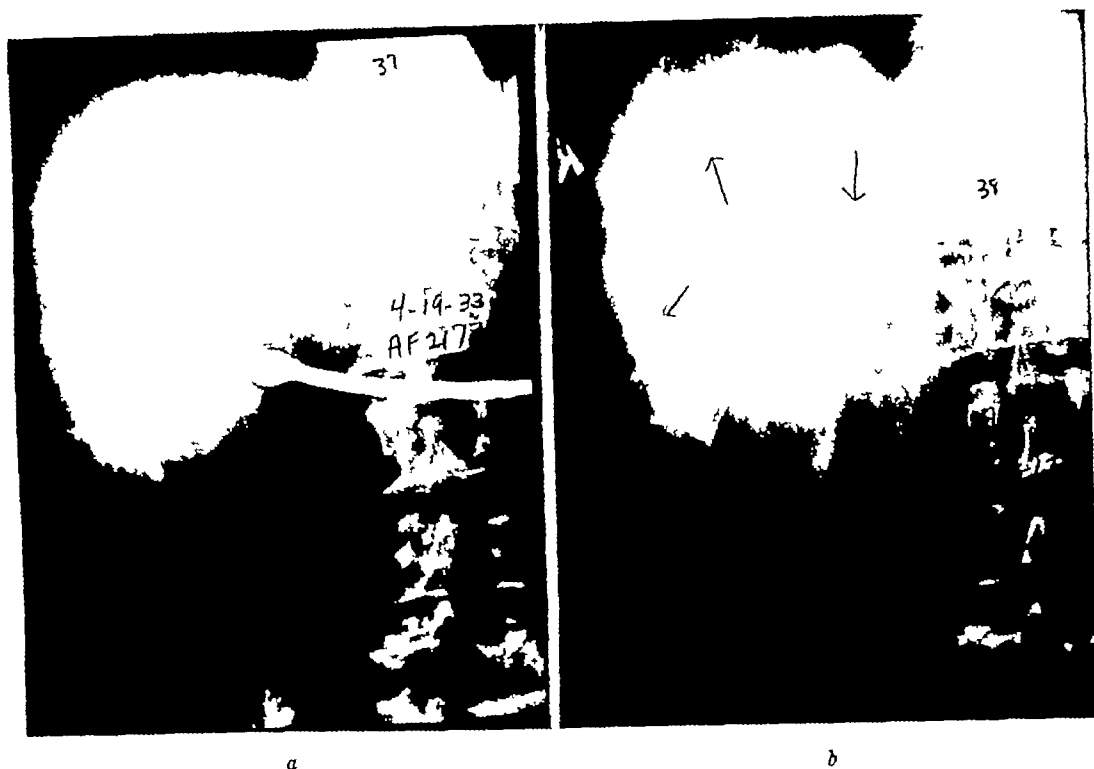


Fig 5 Hepatohemography in a case of carcinoma of the colon (*a*, left) Appearance of liver shortly after injection of thorium dioxide sol showing no evidence of metastasis (*b* right) Same case three months later showing numerous areas of rarefaction (arrows) in the liver, characteristic of metastases, demonstrated without further injection

generation frequently seen in patients dying of carcinoma. It is notable that the thorium is not particularly apparent in the areas of the liver which show the most degeneration.

One case which came to autopsy a little over two years after the injection of thorium dioxide sol is of particular interest. This patient had an extensive carcinoma of the stomach, roentgenologically diagnosed. Following hepatohemography, an extensive reaction of the stomach was done by Dr. Wangenstein. Recovery was uneventful and complete. About two years later the patient developed symptoms which led to another surgical exploration, a carcinoma of the colon being found. This was resected but the patient developed post-operative pneumonia complicated by pleural effusion which had a fatal outcome. At autopsy, the sections of the liver showed somewhat less thorium than we have observed in other patients with a shorter duration after injection. The thorium

granules were clumped largely near the center of the lobules, and appeared to be present in the periportal spaces adjacent to the bile duct, artery, and vein—no doubt in the lymphatics. There was no evidence of fibrosis, giant-cell formation, or leukocytic infiltration. There was some evidence of slight atrophy of the liver cords. Whether this was due to the manner of death—a rather prolonged post-operative pulmonary infection—or to the thorium we cannot determine. There was no apparent difference in the degree of atrophy of the cells adjacent to the thorium and of those at a distance. This case shows little difference in the appearance of the liver after two years from its appearance at from one to nine months.

It is useful to compare these findings with the reports in the literature of severe or moderate damage to the liver and spleen after the injection of thorium dioxide sol. These changes in the liver consist largely of fatty degeneration, atrophy, and fibrosis,

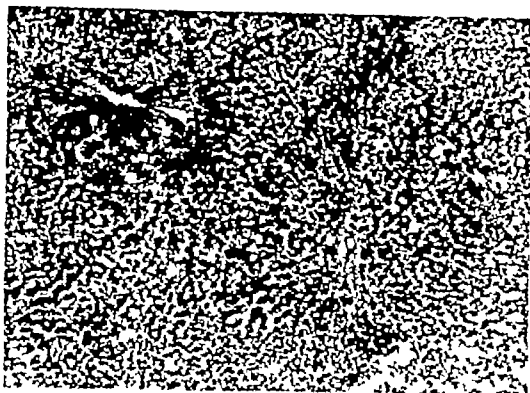


Fig 1



Fig 2

Fig 1 Low power magnification of microscopic section of liver obtained at autopsy about one month after injection of thorium dioxide sol (thorotrast). The granules of thorium can be clearly made out within the reticulo-endothelial cells. They are widely distributed through the liver. Note that there is no evidence of damage to liver cells or stroma.

Fig 2 Same case as shown in Figure 1. The high power magnification shows clearly the appearance of the thorium granules in the cells and the absence of any liver damage.



Fig 3

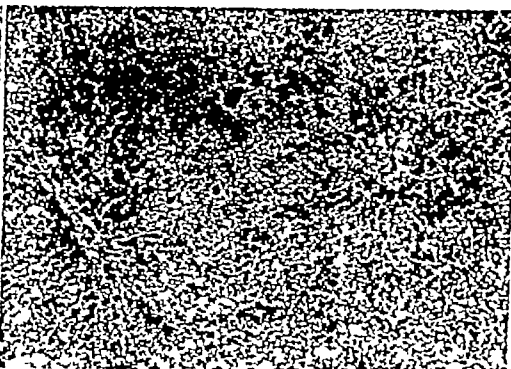


Fig 4

Fig 3 Low power magnification of microscopic section of liver obtained at autopsy about six months after injection of thorium dioxide sol. This illustrates a type of case in which there is chronic passive congestion with resultant liver atrophy. Note the concentration of thorium granules in the cells around the atrophic areas. The appearance of atrophy is similar to that obtained in the usual case of chronic passive congestion.

Fig 4 Low power magnification of microscopic section of liver obtained at autopsy about eight months after injection of thorium dioxide sol (thorotrast). Considerable fatty degeneration of the liver is present, the fat globules being well demonstrated. This is typical of findings ordinarily obtained in patients dying of carcinoma. Note that the cells contiguous to the thorium granules show no more involvement than the other cells.

magnification of a microscopic section of the liver, showing the reticulo-endothelial cells filled with the fine granules of thorium. Figure 2 is a high power magnification demonstrating the same findings. The preservation of the normal structure of the cells adjacent to the mass of thorium and the absence of parenchymatous degeneration, atrophy, or fatty replacement should be observed. In Figure 3 is shown the atrophy associated with chronic passive

congestion. This is typical of the amount seen in these cases regardless of whether or not thorium was previously given. The concentration of the phagocytic cells containing thorium granules around the atrophied areas is striking and indicates somewhat the retention of their normal reaction to injured tissue. The remaining microscopic section—a low power magnification—is shown in Figure 4. Here, there is approximately the usual degree of fatty de-



Fig 7 Hepatolienography in a case of carcinoma of the breast with metastases to the second lumbar vertebra (*a upper left*) Note the homogeneous shadow of the liver clearly delineated, and the characteristic, slightly mottled shadow of the spleen (*b upper right*) Same case re examined one and one half years later shows the typical mottling of the liver shadow and dense nodular shadows along the left border of the liver (arrow) typical of excretion of thorium into hepatic lymph nodes

Fig 8 Hepatolienography in a patient with enlarged spleen of undetermined origin (*a lower left*) Film made shortly after injection of thorium dioxide sol, showing normal liver and enlarged spleen Note the absence of shadows along the left border of the liver (*b, lower right*) Same case three and one half years later A slight mottling of the liver shadow is now apparent The spleen shows about the same size and also an increase in the mottled appearance Characteristic shadows along the left border of the liver representing hepatic lymph nodes filled with thorium are shown (arrow)

Certainly none of the alarming changes observed in animals were found here and it is very questionable whether any of the abnormalities which we observed could fairly be assigned to the thorium dioxide sol

ELIMINATION OF THORIUM

Finally, there arises the question of the eventual fate of the thorium after it has

been injected We have been enabled to re-examine 32 patients of this series Roentgenograms of the liver and spleen in 10 cases were made from three months to one year after the original study In 22 cases the re-examination was done from one to three and one-half years after the introduction of the thorium dioxide sol In most instances there has been little reduction in

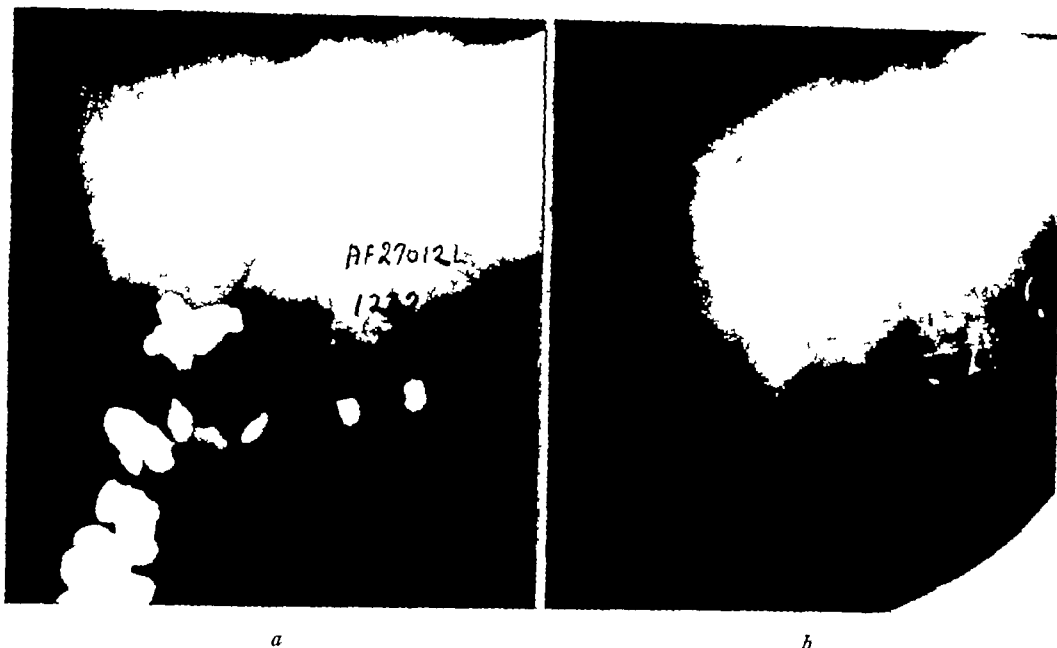


Fig 6 Hepatolienography with follow up examination (a left) First examination, showing a rather small liver with slight mottling, but fairly homogeneous shadow characteristic of normal appearance with thorium dioxide sol (b right) Same case 11 months later showing characteristic mottling of shadow which is frequently found after approximately one year

while in the spleen and lymph nodes there is largely shrinkage of the lymphoid tissue with atrophy and fibrosis, often accompanied by perivascular fibrous tissue proliferation. The exact mechanism by which these changes are produced has not been definitely determined. It seems improbable that it is due to a radiation effect, as the histologic appearance is not at all that of radiation necrosis. A toxic effect is a possibility, this would necessarily have to be specific for the tissues of the liver, spleen, and for lymphoid tissue, as the injection of thorium dioxide subcutaneously produces practically no deleterious effects in the local area. Such a specific toxic effect seems improbable. There is, finally, the possibility that these changes are due to a foreign body reaction. The description of the lymph node changes particularly (9) suggests this type of process. In those experiments in which very large doses were used, the changes appear to be definitely of this character. Reports of leukocytic infiltration approaching abscess formation are probably due to some coincidental infection.

Critical study of our microscopic sections reveals few, if any, of these changes. There are no foreign body giant cells, little, if any, fibrosis, and no perivascular tissue reactions. While it is possible that some of the atrophy demonstrated, e g, in Figure 3, might be due to the thorium preparation, the amount and character of it do not suggest this at all, the congestion being quite sufficient to account for it in its entirety. Likewise, the fatty degeneration might have been caused, at least in part, by the foreign substance, here again the tissue differed in no respect from that frequently found in this type of patient to whom thorium dioxide had not been given. The histologic changes demonstrated bore no apparent relation, as to location, to the thorium granules which were present. The cells closest to the foreign substance showed no greater degree of damage than those at a greater distance.

The impression gained from these histologic studies is that there is little or no damaging effect upon the liver, so far as can be determined by microscopic examination in a nine-month period of observation.



Fig 7 Hepatohemography in a case of carcinoma of the breast with metastases to the second lumbar vertebra (*a* upper left) Note the homogeneous shadow of the liver clearly delineated and the characteristic slightly mottled shadow of the spleen (*b* upper right) Same case re examined one and one half years later shows the typical mottling of the liver shadow and dense nodular shadows along the left border of the liver (arrow) typical of excretion of thorium into hepatic lymph nodes

Fig 8 Hepatohemography in a patient with enlarged spleen of undetermined origin (*a* lower left) Film made shortly after injection of thorium dioxide sol showing normal liver and enlarged spleen Note the absence of shadows along the left border of the liver (*b*, lower right) Same case three and one-half years later A slight mottling of the liver shadow is now apparent The spleen shows about the same size and also an increase in the mottled appearance Characteristic shadows along the left border of the liver representing hepatic lymph nodes filled with thorium are shown (arrow)

Certainly none of the alarming changes observed in animals were found here, and it is very questionable whether any of the abnormalities which we observed could fairly be assigned to the thorium dioxide sol

ELIMINATION OF THORIUM

Finally, there arises the question of the eventual fate of the thorium after it has

been injected We have been enabled to re-examine 32 patients of this series Roentgenograms of the liver and spleen in 10 cases were made from three months to one year after the original study In 22 cases the re-examination was done from one to three and one-half years after the introduction of the thorium dioxide sol In most instances there has been little reduction in

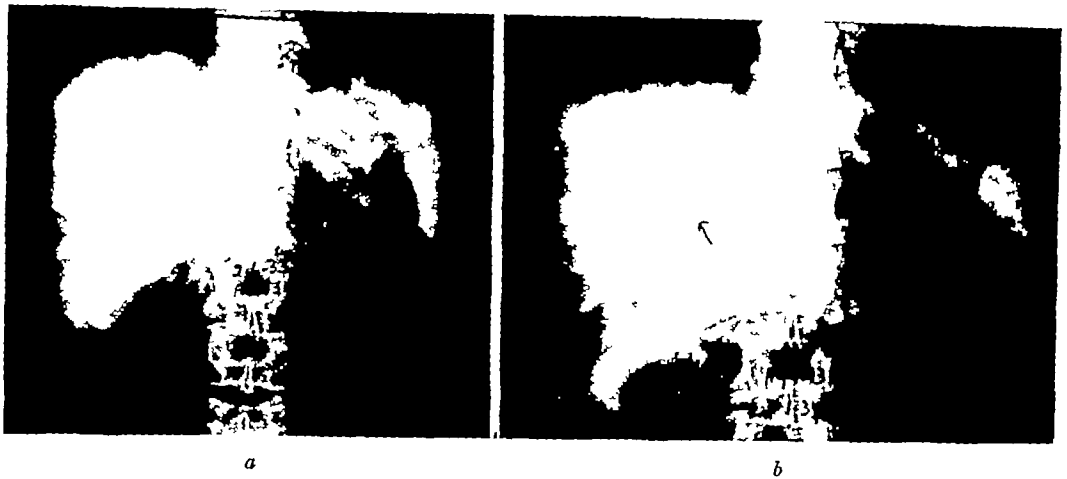


Fig 9 Hepatolienography in a case of carcinoma of the stomach without metastasis (*a left*) Note the shadow of the liver apparently normal as well as a brilliant delineation of the spleen (*b, right*) Same case re-examined about a year and one-half later, shows a peculiar streaked concentration of thorium along the lower margin of the liver and definite hepatic lymph nodes near the spine (arrows) Note the mottled appearance of the spleen and some nodules along its hilus suggesting splenic lymph nodes also filled with thorium

the intensity of the shadow of the liver and spleen. There is a change but it is relatively minor, indicating that only a small amount of the colloid has left these organs in this interval.

As has been previously reported, some advantage can be had from this slow elimination in that repeated roentgen studies of the liver may be made without additional injection. In that way carcinomatous metastases to the liver may appear in later films although they were not present when the first examination was made. Such a case is illustrated in Figure 5. This patient had a carcinoma of the colon, and on the original hepatolienography (Fig 5-*a*) there was seen no evidence of metastases. Resection of the colon was done, and manual exploration of the liver also revealed no evidence of metastases. When the patient returned some three months later for closure of the colostomy, re-examination revealed the typical extensive carcinomatous metastases shown in Figure 5-*b*.

Two characteristic changes are present in the majority of the cases when they are examined a year or more after the injection. There is shown a redistribution of the opaque substance in the liver, the latter shows a marked degree of fine mottling in contrast to the rather homogeneous charac-

ter of the shadow on the original examination. An illustrative case is shown in Figure 6. The roentgenogram made 48 hours after the last injection is shown in Figure 6-*a*, the liver giving the usual homogeneous dense appearance with the vascular tree, and the gall-bladder fossa appearing as areas of decreased density. In Figure 6-*b* the roentgenogram made eleven months later is presented. In this can be seen the finely mottled character of the liver shadow. From the work of Kadrnka (16) and of Naegeli and Lauche (20) on animals, it would appear that this is due to an extension of the thorium dioxide into the lymphatics around the central vein. It may also be due in part to a migration of the reticulo-endothelial cells of the liver to this region. The tendency toward elimination of the injected substance through the lymphatics is thus apparent.

Further evidence of this manner of elimination is afforded in Figure 7. The roentgenogram of the liver made shortly after the injection of thorotrast is presented in Figure 7-*a*. A carcinomatous metastasis to the second lumbar vertebra is clearly apparent. The striking representation of the spleen should also be observed. The examination of the liver one and one-half years later is shown in Figure 7-*b*, and here

may be observed a group of shadows, along the left border of the liver, which are not present on the original examination (Fig 8-a). These are undoubtedly the hepatic lymph nodes into which the thorium dioxide has extended. The characteristic notching of the liver shadow may be noted here also. Further drainage into the mediastinal and diaphragmatic lymph glands would be expected, although we have been unable to demonstrate it in any of our cases. The same phenomenon is illustrated even more strikingly in Figure 8. The original roentgenogram (Fig 8-a) shows a considerable enlargement of the spleen and normal liver. The absence of any abnormal shadows along the left border of the liver may be noted. In Figure 8-b is shown the roentgenogram obtained about three and one-half years later, and the characteristic appearance of the hepatic lymph nodes filled with the opaque substance is clearly shown. The absence of any particular change in the size of the spleen is strong evidence against the occurrence of atrophy of the lymphoid structures which has been described in animals. It should be noted in this case that a period of three and one-half years has failed to diminish the intensity of the liver and spleen shadows.

The case illustrated in Figure 9 is somewhat different from the usual finding. The first roentgenogram (Fig 9-a) demonstrates a fairly large liver, otherwise normal, and an unusually well-defined spleen. On re-examination about 19 months later (Fig 9-b), the hepatic lymph nodes are well shown, but there is in addition an unusual concentration of the thorium dioxide in a linear fashion under the costal margin. This is probably due to the presence of some unusually large lymphatics in this area.

These findings correspond exactly with those of Naegeli and Lauche (20), who report a study on one dog over a period of three years. Repeated biopsies of the liver have shown relatively little damage although two to three times the usual dose was given. The dog has survived numerous laparotomies and other surgical procedures.

An abdominal exploration at the end of the third year revealed the hepatic lymph nodes filled with thorium granules. These authors sound another warning as a result of this observation. They believe that there may be a greater concentration of the thorium in the lymph nodes than in the liver, hence a more marked necrotic and atrophic effect might be possible. In actuality, the biopsies in this one dog indicate areas of necrosis in the lymph nodes but they are well encapsulated. There is, however, a definite atrophy and diminution in amount of the lymphoid tissue.

The reports of Leipert (17) and other investigators (20), that large quantities of thorium dioxide sol may be eliminated from the body within a year, seem to be contradicted by our comparative studies in clinical cases. Whatever elimination takes place from the liver seems to extend into the lymphatics and lymph nodes but the thorium is still present in the body. An examination of the roentgenograms shown in Figure 8, taken almost three and one-half years apart, indicates clearly how slowly this removal of the thorium takes place. This fact, no doubt, presents the most serious objection to the use of this substance for roentgen diagnosis.

SUMMARY

We may summarize our experience with the use of thorium dioxide sol (thorotrast) for roentgen diagnosis of the liver and spleen in 175 patients as follows:

- (1) The procedure permits of highly accurate diagnosis, particularly of metastatic or primary carcinoma of the liver.

- (2) With rare exceptions, the immediate reactions to the injection are of no importance.

- (3) No apparent change in the resistance of the patients injected with this substance could be determined.

- (4) There were no deleterious effects, observed over a period of years, that could in any way be assigned to the thorium.

- (5) Autopsy studies in 35 cases revealed little or no damage to the liver which could

fairly be ascribed to the procedure of hepatohenography

(6) Repeated roentgen examinations on 22 cases from one to three and one-half years after the injection indicated little or no elimination of the injected material from the body

(7) Redistribution of the thorium into the lymphatics of the liver and extension into the hepatic lymph nodes was observed in almost all the cases that were re-examined after a year or more had elapsed

CONCLUSIONS

Little or no harm can be demonstrated, as yet, from the use of thorium dioxide sol when used in small doses in the roentgen examination of the liver and spleen in humans

Nevertheless, caution should be exercised in its use because of the following reasons (1) the eventual radio-activity of the material has not yet been determined, (2) it is eliminated very slowly, if at all, so that a foreign body will remain in the liver and spleen, (3) the extension into the lymph nodes in greater concentration may produce atrophy of the lymphoid tissue, the eventual results of which cannot yet be predicted

It would be well, for several years to come, to confine its use, when injected intravenously in large enough doses for proper demonstration of the liver and spleen, to older individuals suffering from very grave diseases

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RIB DEFECTS SIMULATING PULMONARY CAVITATION

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DEVELOPMENTAL and pathologic changes in the ribs as seen in radiographs may simulate cavitation in the underlying lung. The cavities most frequently seen in radiographs of the chest are produced by tuberculous cavitation, the cavitation of an abscess, and air-containing pockets due to broncho-pleural fistulae.

Accurate information as to the presence of cavitation in the lungs is usually of great clinical importance. The shadow of a cavity may be the deciding factor in making a positive diagnosis of tuberculosis in an area of infiltration of doubtful nature. Collapse therapy in tuberculosis is based primarily upon the presence of cavitation. Simple infiltration or consolidation, which has been produced in the lung by a non-tuberculous type of infection, does not call for surgical interference, but if an abscess cavity is found in such an area, operation may be indicated.

At the Cleveland City Hospital there have been observed 14 cases in which the radiographs showed changes in the ribs which could readily simulate cavitation if there were a pathologic process present in the underlying lung. Sweaney (1) has made similar observations. The confusing shadows in the cases to be presented are produced by anomalous rib development or by a portion of a rib which has enlarged to enclose an area of bone absorption. This expanded portion of bone casts an annular shadow of increased density, which may be mistaken for the zone of infiltration or fibrosis which often surrounds a cavity in the lung. The central area of lesser density casts a shadow similar to that produced by air in a pulmonary cavity. White (2) has mentioned bifurcation of the ribs, and Fleischner (3) has noted fenestration.

In some of the cases to be presented, close inspection will show the true nature of

the annular shadows because there are no pathologic changes in the underlying lungs, but the presence of infiltration or fibrosis in these areas could very easily mask the outlines of the expanded ring of bone in the rib and give rise to a false diagnosis of pulmonary cavitation. In cases of doubt, more heavily exposed films from varying angles, or stereoscopic films should aid in determining whether the shadow is produced by a cavity in the lung or by unusual configuration of the rib overlying that area.

CASE REPORTS

Case 1 A white male, aged 19 years, was admitted four months after pulmonary tuberculosis had been diagnosed elsewhere. A radiograph of the chest showed densely mottled and streaked shadows in the upper half of the right lung-field and in the lower right hilar area. There was an area of rarefaction 2 cm. in diameter just beneath the right clavicle, which was diagnosed as a cavity in an area of tuberculous infiltration in the lung. Pneumothorax was instituted because of the cavitation. Two months later there was an hemoptysis of two ounces. A few days after the hemoptysis, suspicion arose that the cavity might have been in a rib. Further radiographs from different angles and of greater density, using Bucky diaphragm technic, proved that the cavity was in the first right rib and not in the lung. Sinuses developed in the chest wall. Incision revealed necrotic bone in the rib and tubercle bacilli were found in the material obtained from it. Communication with the hospital in which the patient was previously diagnosed as being tuberculous revealed the cavity in the rib to have been diagnosed there, also, as a pulmonary cavity.

Case 2 A colored male, aged 22 years, was diagnosed, in 1926, as having pulmo-



Fig 1 Case 1 Regular exposure, diagnosed as pulmonary cavitation



Fig 2 Case 1 Heavy exposure, showing cavity to be in the rib and not in the lung

nary tuberculosis Tuberculous infection of the ilium was found at that time In 1929, tubercle bacilli were found in pus draining from the right malar bone A soft tissue swelling over the second and third right ribs, anteriorly, resolved without suppuration after ultra-violet light therapy A recent film of the chest showed the upper mediastinal shadow to be enlarged to the right Between the third and fifth right ribs, anteriorly, was seen an area of cloudy increased density Near the center of this area was seen a denser ring 3 cm in diameter enclosing a space of lesser density having the appearance of a cavity Closer inspection reveals the anterior end of the fourth right rib to be expanded and to enclose a cavity 2 cm in diameter in the rib The lung beneath this deceptive shadow contained infiltration but no cavity

Case 3 A white male, aged 22 years, was known to have had pulmonary tuberculosis A film of the chest showed mottled and streaked shadows throughout the upper two-thirds of the left lung due to tuberculous infiltration and fibrosis There was increased density about the right hilus, and in this dense region was a rarefied shadow, probably due to a pulmonary cavity In

the second left interspace was an annular shadow 3 cm in diameter, which undoubtedly was due to a pulmonary cavity In the region of the second costal cartilage (which ordinarily casts a very faint or no shadow) was a circular shadow of lessened density 2 cm in diameter surrounded by a ring of increased density The first impression, since the patient was known to have had pulmonary tuberculosis with cavitation, was that this annular shadow represented another cavity in the lung, but closer inspection showed the sixth right rib to have a double origin and to be attached to two vertebræ The space between the two heads of origin produced the appearance of a cavity

Case 4 A white girl, aged 11 years, was subjected to resection of the ninth left rib, in June, 1934, to drain an empyema following scarlet fever In November, 1934, drainage still persisted, and a bronchopleural fistula was demonstrated A radiograph of the chest showed haziness in the lower third of the left lung-field, and through this haziness was seen an annular dense shadow 3 cm in diameter enclosing a rarefied area Closer inspection revealed this shadow to be due to bone regeneration



Fig 3 Case 4 Deformity of rib following resection

from the bed of the resected portion of the eighth rib. Bone regeneration of this type is fairly common.

Case 5 A white male, aged 70 years, complained of cough, shortness of breath, and loss of weight. A film of the chest showed haziness at each apex, with fibrotic shadows scattered about each apex and along the entire mediastinal border of the right lung. The first left rib was wider than is usually seen and contained a well defined area of bone absorption. Through the shadow of the first right rib was seen an irregularly outlined area of lessened density which probably would have been diagnosed without question as a pulmonary cavity, because of the presence of infiltration and fibrosis in that area, had not the rib on the opposite side shown such a well-defined cavity. A heavily exposed film from a different angle was required to obtain the correct diagnosis of a cavity in the first right rib.

Case 6 A colored male, aged 30 years, complained of cough and expectoration for four months, and of a tender spot in the upper right thorax, anteriorly. A radiograph showed irregular shadows of increased density in the upper third of the right lung-field. The markings in the area draining the left apex were of increased thickness.



Fig 4 Case 5 Cystic changes in right and left first ribs

There were shadows of cavities in the upper fourth of the left lung-field. The second right rib was irregular. Pus that contained tubercle bacilli was aspirated from the tender spot in the right side of the thorax. Heavily exposed films demonstrated cavities in the first and third left ribs but not in the lung.

Case 7 A white male was referred without history for a radiograph of the chest. The markings about each hilus were of increased thickness. The interlobar septum on the right side was thickened. The anterior portion of the third left rib was wider than is usually seen and formed a circular shadow 3 cm in diameter. The left lung was quite clear and the nature of the shadow was evident, but if a pathologic change in the lung had been present, confusion in diagnosis might have arisen.

Case 8 A colored female, aged 46 years, was referred for a film of the chest because of symptoms suggestive of tuberculosis. There were a few shadows of calcification in the second right interspace. The markings in each subapical region were rather heavy. Through the shadow of the anterior portion of the first left rib was seen a rarefied area 1.5 cm in diameter, which was shown on closer inspection to be due to a cyst-like area of absorption in the rib. If there had been pathologic changes in the apex of the lung that would blur the outlines of the rib, this area of bone absorption might have been mistaken for a cavity in the lung.

Case 9 A white male, aged 55 years,



Fig 5 Case 13 Osteomyelitis of ribs following compound fractures

was admitted because of diabetic gangrene in the foot. A film of the chest was requested because of a cough. The markings were somewhat increased in number and density throughout both lungs. Through the shadow of the first right rib was seen a round area of diminished density 1 cm in diameter. The outline of this rib was of the same size and shape as the corresponding rib on the opposite side. A more heavily exposed film demonstrated the cavity to be in the rib and not in the lung.

Case 10 A white male, aged 25 years, was referred for radiographic examination of the chest because of a cough and family history of tuberculosis. Many fibrous strands were seen in the area draining the right apex. A spur of bone extended medially and upward from the midportion of the second right rib to make contact with a spur extending laterally from the first rib. The underlying lung was clear enough so that the nature of the curving shadow was apparent, but if dense infiltration had been present it is not unlikely that a mistaken diagnosis of cavitation in the apex, above

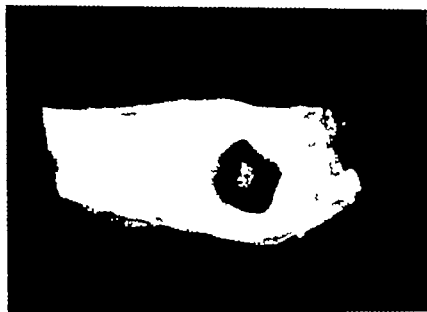


Fig 6 Case 14 Autopsy specimen
Cavity in expanded rib

the spur, would have been made, as the curved spurs could simulate the dense wall of a cavity.

Case 11 A white male, aged 45 years, complained of fever, shortness of breath, and pain in the right side of the chest. The film exhibited marked density in the lower third of the right lung-field, gradually fading out toward the apex. Through the haziness in the middle third was seen an oval area of rarefaction 2×4 cm in size, surrounded by a dense ring. This had the appearance of cavitation in the lung with pleural effusion. A large amount of fluid was removed from the pleural cavity. The removal of the fluid permitted much better visualization of the chest, and in another film the shadow, which had appeared to be that of a large cavity in an infiltrated lung, was seen to be due to a deformed rib. Other ribs were then seen to be deformed, and it was found that the patient had suffered from an accident a year or two previously, the accident being followed by drainage of pus from a wound in the thorax. The cystic area in the rib, with the surrounding expanded ring of bone, was probably due to osteomyelitis subsequent to a compound fracture.

Case 12 A white male, aged 40 years, under routine examination showed an apparent cavity at the apex of the right lung. The first right rib was markedly enlarged anteriorly, measuring 4 cm in width. A cyst-like cavity was seen in the expanded portion of the rib, the thin borders of the rib producing the illusion of a cavity in the lung.

Case 13 A white male, aged 41 years, was examined because of signs indicative of tuberculosis. In the fifth left interspace was seen a definite area of infiltration. The cardiac outlines were blurred by pericardial thickening. There was a synostosis between the first and second right ribs, the bridge of bone connecting these ribs being curved so that the question of cavitation in the lung would probably have arisen had infiltration been present in the upper fourth of the right lung.

Case 14 A colored male, aged 42 years, with signs and symptoms very suggestive of pulmonary tuberculosis, showed in the chest film many small nodular and streaked shadows in the upper third of the right lung-field and at the left apex. There were shadows suggesting small cavities at each apex. In the lower right hilar area there was a shadow that strongly suggested a cavity. There was a slight deformity of the fifth right rib, the cavity lying within the shadow of the rib. There was uncertainty as to whether the cavity was in the rib or in the lung. At autopsy, the cavity was found to be in the anterior portion of the fifth rib.

Microscopic examination revealed no active inflammatory process in the rib, but it was thought that the cavity was due to tuberculous osteomyelitis.

SUMMARY

Fourteen cases exhibiting possible sources of error in the radiologic diagnosis of pulmonary cavitation have been presented. Four of them had congenital malformation of the ribs. One had deformity of a rib following its resection. In nine cases, annular dense shadows with rarefied centers were produced by bone surrounding a cavity due to infection or a cystic change in a rib, the width of the ring of bone being much greater than the normal size of the rib.

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RETARDATION OF BONE GROWTH FOLLOWING ROENTGEN IRRADIATION OF
AN EXTENSIVE NEVO CARCINOMA OF THE SKIN IN AN INFANT
FOUR MONTHS OF AGE¹

By ROLLIN H. STEVENS, M.D., *Detroit*

REPORT the following case, from Grace Hospital, Detroit, because of its interest, particularly from four stand-points

(1) The case is one of an extensive vascular nevo-carcinoma of the skin of the left thigh, vulva, and left lower quadrant of the abdomen in a child four months of age

(2) It was treated with 200 kv roentgen therapy, after which the growth completely disappeared and the child has remained free from evidence of carcinoma for five years

(3) There followed a marked retardation in the growth of the pelvis, femur, tibia, and fibula on the affected side, although the radiation was confined to the upper two-thirds of the femur, the left lower quadrant, and the vulva

(4) Four years and nine months later, staphylococcic osteomyelitis of the left femur developed

There has been a good deal said about the arrest of soft tissue growth, but we have not found much in the American literature, at least, on the subject of retardation of bone-growth by irradiation. Recently, Haensch² reported a case of a young girl, about three years of age, whose breast was irradiated post-operatively for some kind of growth in the upper arm. Many years later, there was noted a marked retardation of all the tissues in the field—mammary, skin and its appendages, half the thoracic wall, scapula, clavicle, and humerus. Haensch gives a brief review of the literature of the subject—all European—concerning biologic experimentation and clinical observation.

HISTORY

J. D. C., female, Italian, born July 12, 1929, was first seen by Dr. A. Font, and brought by him to Grace Hospital on Oct. 31, 1929. Her weight was 11 pounds, 5 ounces, her temperature was 104° (R). There were scattered râles throughout the chest. There was a vascular swelling, 10 cm. in diameter, involving the whole of the left thigh, vulva, and lower abdomen, and the parents said it was growing rapidly. They stated that the growth was present as a purplish lesion at birth, and involved a small area in the middle of the anterior portion of the left thigh. The left thigh was swollen to more than three times its normal size, and the swelling extended into the vulva and across the abdomen. The involvement of the latter two areas was very recent. The color was a dark purplish-brown, being more purple over the abdomen.

Dr. Font made a biopsy, and a severe hemorrhage, very difficult to control, followed. The pathologic report by Dr. Clarence Owen, pathologist of Grace Hospital, was as follows: "Epidermis negative. In the cutis are several areas of nevus cells, exhibiting marked anaplastic tendencies, with formation of spindle cells. No alveolar or acinous formations present. The diagnosis was nevo-carcinoma."

At the earnest request of the parents, x-ray therapy was begun on Nov. 5, 1929, although we had no hope of accomplishing anything beneficial, and we pointed out to the parents that the ovaries would be destroyed and unknown disturbances of metabolism might result.

Treatment was given as follows: 200 kv., 1 mm. Cu and 1 mm. Al filter, 30 ma., 50 cm. distance, 122 r at a dose, November 5, 9, 11, 12, 13, 14, 15, and 16, respectively—a

¹ Presented before the Radiological Society of North America at the Twentieth Annual Meeting at Memphis, Tenn., Dec. 3-7, 1934.

² G. F. Haensch, *Fortschr. a. d. Geb. d. Röntgenstrahlen*, July 1934, 50, 78-86.

total of 976 r in 11 days. At the end of this time the tumor was growing, and became more and more painful, so the treatment was discontinued. After two or three weeks, however, the child improved, the tumor grew smaller and the pain subsided. This improvement continued for two or three weeks and came to a standstill. We were encouraged and urged to resume treatment. Accordingly, on Jan 2, 1930, we started treatment again on a "saturation" technic. An area 20×10 cm on the thigh anteriorly and posteriorly, and extending over the lower abdomen, was treated daily, with 1 mm of copper and 1 mm of aluminum at 50 cm distance, 200 kv and 30 ma, until Jan 20, 1930, giving an estimated total effective depth dose in the bone of about 840 r in 18 days. The tumor rapidly diminished so that within three or four weeks after the end of the treatment the left thigh was about the same size as the right, and the swelling had left the vulva and abdomen. The skin became red, then brown, and desquamated moderately.

Progress Notes—The following is a synopsis of progress notes and laboratory findings in Grace Hospital. On Oct 15, 1929, and for the next seven days after admission, the temperature range was from 100.4° (R) to 104° (R). During the month of November the temperature was slightly above normal, ranging from 99.8 (R) to 101.6 (R), 101.6 (R) was the temperature recorded the day after completion of the first series of deep x-ray therapy. The thigh showed no improvement, the carcinoma continuing to grow getting much darker, more painful, and swollen. The temperature varied only slightly above normal for the remainder of November. On Oct 6, 1929, her weight was 12 pounds and 6 ounces. The temperature was normal for December. Further x-ray treatment was given during January with considerable improvement. The patient at times was quite nauseated after treatment, there was no rise in temperature. On Feb 6, 1930, the temperature started to rise and was 100.6 (R). The following two days the temperature varied between 104.2 (R) to 101.8 (R). No ap-

parent explanation for the rise in temperature was found, it came down gradually, being normal on Feb 13, 1930.

Roentgen and Laboratory Reports—Roentgenograms taken on Oct 16 and 31, and on Nov 19 and 26, 1929, revealed no bone pathology of the left femur, rather dense hilar shadows in the chest, and considerable increase in density and width of pulmonary markings throughout the central and middle areas of both lung-fields. The possibility of lymphatic intrathoracic neoplastic metastases must be considered, although one must also consider a possible bronchopneumonic foci or a chronic bronchitis. On Feb 6, 1930, a re-examination of the chest and long bones, after a course of x-ray therapy, revealed no convincing evidence of neoplastic invasion. On Oct 16, 1929, a white blood count showed 17,500 leukocytes, 43 per cent neutrophils, and 57 per cent small lymphocytes. Blood Wassermann was negative. On Feb 6, 1930, the blood count was hemoglobin, 56 per cent, red blood cells, 3,350,000, white blood cells, 6,400, neutrophils, 65 per cent, large lymphocytes, 10 per cent, small lymphocytes, 25 per cent. The patient was discharged from Grace Hospital on March 6, 1930.

We did not see the child again until Oct 4, 1933, when she was brought to the hospital by Dr Font. She was then four years old. She appeared to be perfectly well except for a shortening of about two inches of the left limb. The parents informed us that she had started to walk at the age of 18 months, and the shortening was first noticed in the Spring of 1932, about fifteen months after the deep therapy. Her parents stated that the lameness was continually growing worse. There was some slight atrophy of the skin and other soft tissues of the limb. The roentgen examination was reported as follows: "Re-examination of the chest reveals no convincing evidence of neoplastic metastases anywhere in the chest. There are pulmonary changes, however, which we believe could be best interpreted as evidence of a chronic, rather pronounced bronchosis, although tuber-

RETARDATION OF BONE GROWTH FOLLOWING ROENTGEN IRRADIATION OF
AN EXTENSIVE NEVO-CARCINOMA OF THE SKIN IN AN INFANT
FOUR MONTHS OF AGE¹

By ROLLIN H. STEVENS, M.D., *Detroit*

REPORT the following case, from Grace Hospital, Detroit, because of its interest, particularly from four stand-points

(1) The case is one of an extensive vascular nevo-carcinoma of the skin of the left thigh, vulva, and left lower quadrant of the abdomen in a child four months of age

(2) It was treated with 200 kv roentgen therapy, after which the growth completely disappeared and the child has remained free from evidence of carcinoma for five years

(3) There followed a marked retardation in the growth of the pelvis, femur, tibia, and fibula on the affected side, although the radiation was confined to the upper two-thirds of the femur, the left lower quadrant, and the vulva

(4) Four years and nine months later, staphylococcic osteomyelitis of the left femur developed

There has been a good deal said about the arrest of soft tissue growth, but we have not found much in the American literature, at least, on the subject of retardation of bone-growth by irradiation. Recently, Haensch² reported a case of a young girl, about three years of age, whose breast was irradiated post-operatively for some kind of growth in the upper arm. Many years later, there was noted a marked retardation of all the tissues in the field—mammary, skin and its appendages, half the thoracic wall, scapula, clavicle, and humerus. Haensch gives a brief review of the literature of the subject—all European—concerning biologic experimentation and clinical observation

HISTORY

J. D. C., female, Italian, born July 12, 1929, was first seen by Dr. A. Font, and brought by him to Grace Hospital on Oct. 31, 1929. Her weight was 11 pounds, 5 ounces, her temperature was 104° (R). There were scattered râles throughout the chest. There was a vascular swelling, 10 cm in diameter, involving the whole of the left thigh, vulva, and lower abdomen, and the parents said it was growing rapidly. They stated that the growth was present as a purplish lesion at birth, and involved a small area in the middle of the anterior portion of the left thigh. The left thigh was swollen to more than three times its normal size, and the swelling extended into the vulva and across the abdomen. The involvement of the latter two areas was very recent. The color was a dark purplish-brown, being more purple over the abdomen.

Dr. Font made a biopsy, and a severe hemorrhage, very difficult to control, followed. The pathologic report by Dr. Clarence Owen, pathologist of Grace Hospital, was as follows: "Epidermis negative. In the cutis are several areas of nevus cells, exhibiting marked anaplastic tendencies, with formation of spindle cells. No alveolar or acinous formations present. The diagnosis was nevo-carcinoma."

At the earnest request of the parents, x-ray therapy was begun on Nov. 5, 1929, although we had no hope of accomplishing anything beneficial, and we pointed out to the parents that the ovaries would be destroyed and unknown disturbances of metabolism might result.

Treatment was given as follows: 200 kv, 1 mm Cu and 1 mm Al filter, 30 ma, 50 cm distance, 122 r at a dose. November 5, 9, 11, 12, 13, 14, 15, and 16, respectively—a

¹ Presented before the Radiological Society of North America at the Twentieth Annual Meeting at Memphis, Tenn. Dec. 3-7, 1934.

² G. F. Haensch, *Fortschr. a. d. Geb. d. Röntgenstrahlen*, July, 1934, 59, 78-86.



Fig 3 June 19 1934 showing staphylococcic osteomyelitis



Fig 4 Nov 21, 1934 showing osteomyelitis healed There is shortening of the right femur

indurated entire left thigh, with increased heat and fluctuation, and two inches shortening of the femur *Laboratory Findings* White blood cells, 34,000, polymorphonuclears 89 per cent, urine negative, Kahn test negative *X-ray* Definite but early osteomyelitis of the left femur in its middle third *Course* temperature 101 degrees, pulse, 100, patient was operated upon the day of admission, lateral and mesial incisions, 8 ounces of pus obtained, saucerization done, through-and-through drains, *Cast* Culture report, *Staphylococcus albus*, developed large area of induration over the lower abdomen on left side, left groin, and upper thigh Blood transfusions were given on June 28 and 29 Old incisions opened more widely on July 7, 1934 Induration gradually decreased The patient was sent to the Crippled Children's Hospital at Farmington on July 31, 1934, readmitted to Children's Hospital on Oct 23,

1934, because of the development of a flexion contracture of the left hip Hip manipulated under gas on Nov 10, 1934, after a period of skin traction and bent frame failed to correct it The patient remained in the hospital and check-up x-rays were taken All wounds of the left thigh were healed

Roentgenograms were made on Nov 21, 1934 They showed the field of saucerization healed over nicely In the lower end of the femur, however, there was marked demineralization, and the diaphyses of the upper ends of the left tibia and fibula exhibited changes suggestive of green-stick fracture

COMMENTS

The problem here of treating, by radiation, a carcinoma in an infant five months of age is very different from the problem of treating an adult All the tissues, normal



Fig 1 Oct 20, 1929 taken before first series of treatments



Fig 2 Oct 20, 1933 taken four years after treatment. There is shortening of the right tibia and fibula

cular etiology—childhood type tuberculosis—may have to be ruled out by further investigations. The development of the thoracic cage is entirely symmetrical. A comparative examination of the pelvis and the lower extremities, exclusive, however, of the feet, shows a marked retardation of the growth of the entire left lower extremity, including the pelvis, so that the left leg is considerably shorter than the right. Taking into consideration the differences in opacity of the two extremities produced by the differences in their size, we feel, nevertheless, that the *left-sided osseous structures are somewhat porotic and more loosely structured*, besides being smaller in all diameters. The most striking change observed, however, is a certain *broadening of the left femoral neck*, combined with *quite irregular outline of the epiphyseal border and markedly irregular structure of the distal left femoral epiphysis*."

She was next seen by us on June 2, 1934, when the shortening of her leg seemed to be increasing. Roentgen examination, however, revealed a condition differing but little from that of Oct 4, 1933. The left limb felt hot and she had a slight temperature. The case was then lost from our care. Just recently we have learned she had been sent to the Children's Hospital, in June, 1934, by a Board of Health nurse who had been visiting one of the other children at their home, and had been at the hospital ever since.

Dr Grover Penberthy, Surgeon at the Children's Hospital, into whose care the case was given on June 19, 1934, has kindly furnished me the following condensed report on the case since that time.

J. D. C., white, aged 5 years, was admitted on June 19, 1934. *History* Swelling of left thigh for five weeks, with four days of fever. *Examination* Swollen, tender,

promoting and differentiating agents on the left side, by the radiation, may have been responsible for the changes noted in the tissues of this child. It could hardly be a central agent, such as the pituitary for instance, for interference with a general internal secreting gland would have affected both sides of the body. It must have been some tissues in the direct field of irradiation on the left side. Harris quotes a case of tuberculosis of the knee joint in a youth 17 years of age, in which the femur on the diseased side became an inch longer than its fellow. Humphrey's explanation of this is "We suppose the disease in the lower part of the shaft of the femur acted as a stimulus to preternatural activity of the growing processes in the epiphysial line."

Harris states that "it would appear that a low-grade tuberculous infection or increased resistance, on the part of the patient, might lead to overgrowth in the bones, whereas severe infection or lowered resistance might lead to arrest of growth."

He refers to a case of tuberculosis of the knee of five years' duration, in which the diseased limb was 2 cm. shorter than its fellow. He shows by roentgenograms that there was diminished growth in the length and the diameter which was not localized at the ends of the bones adjoining the knee, *but was shared by the distal extremity of the tibia*. He says this must not be interpreted as evidence of decreased interstitial growth, it is a direct result of the fact that the *rate of proliferation* of the cells in the cartilage columns at the epiphysial line is less on the diseased side than on the sound side. That may be true, but why should the rate of proliferation of the cells in the cartilage columns be less on the whole side, when the diseased process involved only the knee? Any toxins from the tuberculous process absorbed by any part of the circulatory system should affect the whole body.

There seems to be an analogy here between the effect of a local disease process involving cartilage and the roentgen effect on cartilage. Are the effects noted in the two cases the result of insult to the local distribution of the sympathetic nerve which

normally would have control over the differentiating and growth-promoting activities of these cells?

Honor B. Fell (quoted from Harris) has succeeded in growing "in a small tissue chamber the early limb buds of a chick. The isolated fragment from the proximal part of the limb grows and differentiates in the tissue chamber. The mass of mesenchyme grows, the cartilaginous femur appears with well-demarcated extremities, and the cartilage cells become oriented to form columns of cells in the region of the epiphysial growth—cartilages. The matrix of the cartilage calcifies, new bone is formed, and the resulting femur bears a striking resemblance to the normal in its general configuration and histologic structure." This was apparently accomplished by using a properly balanced embryonic nutritive fluid. It would be interesting to repeat this experiment by subjecting the nutritive fluid to short wave radiation before it is used.

CONCLUSIONS

Whatever the mechanism, it is apparent from our experience with this case and the reports of Haensch's case, that

(1) Young growing skin, soft tissues, and growing cartilage may be retarded in their growth for at least several years, and their hereditary characteristics may be changed by intensive more or less homogeneous short wave radiation.

(2) That, while one side of the pelvis and the upper half of the thigh only so irradiated may suffer such changes, the tibia and fibula of the same side, which were not in the path of the rays, may undergo a similar retardation of growth.

(3) That retarded poorly differentiated bone, resulting from irradiation, may have a very weak resistance to infection for several years after the irradiation.

(4) That great care should be taken in the radiation treatment of children, particularly infants. Only very light treatments should be given to young children in any disease, except when, as in this, life is at stake and the disease requires heavy radia-

and pathologic, of the child of this age are much more embryonal in character, and consequently much more sensitive to x-radiation

The most important tissues in the line of direct radiation were those of the skin, sexual organs, the intestinal tract, and the bones. The epidermis, as is generally known, is sensitive to radiation, but has wonderful powers of recovery, providing its nutritive functions resident in the subjacent cutis, which is not so sensitive to radiation, are not damaged to too great an extent, especially by any caustic action of the rays

There appears to have been no serious damage done to the intestine, although the colon on the left side and the rectum received a considerable dose of radiation. The ovarian function, of course, should have been destroyed beyond possible repair, although it will be some years before we can know for a certainty just what has happened there

Several papers, and a recent book by H. A. Harris, concerning the histologic anatomy of developing bone, the experimental and clinical study of diseases of bone, especially rickets, scurvy, tuberculosis, syphilis, etc., are full of interest when studied in connection with this case

By a clever piece of work, Harris claims to have demonstrated mitoses in cartilage cells, and to have localized the zones of active mitoses in the cartilage skeleton of the embryo. He found an "annulus" of mitotic cells in the ends of long bones, which, multiplying, grow out in three directions, to form the articular cartilage, the cartilage of the epiphysis, and the cartilage of the epiphysal line. The pattern of growth of these cells, which later becomes calcified, is the later pattern of the bone. These dividing cells give rise to "diaphysal bone with its high osteogenetic power in repair, epiphysal bone with a low-grade power of osteogenesis in repair, and hyalin cartilage with minimal powers of repair"

The nutrition of these three parts concerned in growth in the cartilaginous stages is similar to that of the skin. The develop-

ment of generation after generation of cartilage cells from the "annulus" of mitotic cells to gradually aging cartilage cells, which finally die and are cast off, the matrix becoming calcified, is a process comparable to the development of the stratum squamosum from the stratum germinativum of the epidermis. The sensitivity of the multiplying cells of the epidermis, during mitosis to radiation, is well known. It is fair to assume there may be a similar radiosensitivity on the part of the cartilage cells in a similar stage of reproduction. Is it possible that varying degrees of monstrous cartilage cells may appear as a result of their being irradiated, which would produce a poorly differentiated type of bone?

But what caused similar changes in the tibia and fibula which were not radiated?

It would seem that a direct or indirect disturbance of the chemistry of the circulating nutritive fluids of the side irradiated might be responsible. There has not been a great deal of work done on the chemistry of cells as yet, but considerable has been learned from tissue culture *in vitro*

This Society is familiar with the pioneer work of Burrows in tissue culture, and, later, Ernst's part with Burrows in the effects of radiation on growth-promoting and cell-differentiating fluids. It will be remembered that Burrows demonstrated a growth-promoting substance he called "archusia," and an antagonistic cell-differentiating fluid called "ergusia." According to Harris, the former, archusia, is similar to water-soluble vitamin B, the latter, ergusia, is similar to fat-soluble vitamin A, while vitamin D is a fat-soluble calcium-distributing agent in the presence of calcium phosphate. Archusia and vitamin B cause the cartilage cells to proliferate, ergusia and vitamin A bring about differentiation of cells into true bone cells, while vitamin D is responsible for the mineralization. But surely all these three agents should be in proper balance, or the one might gain ascendancy over the other and abnormal changes would result. Some more or less permanent disturbance of the origin of one or more of these growth-

DR WILLIAM H SARGENT (Oakland, Calif) For several years I have been using unfiltered radiation in doses of from 4,000 to 6,000 r in the treatment of superficial malignancies. When treating lesions about the mouth and nose, severe reactions will occur upon the underlying mucous membrane of the cheek, gum, or tongue or in the nasal passages unless these structures are protected. I should like to ask the Doctor if he has noticed similar reactions from the doses of heavily filtered radiation.

Regarding the malignant involvement of cartilage, it has been my observation that if the perichondrium only on one side of the cartilage has been destroyed, healing is extremely difficult to obtain, even though the malignancy has been destroyed. A chronic inflammatory condition or perichondritis develops around the denuded area of cartilage which slowly spreads and often becomes very painful. A recurrence may be suspected and further treatment given, which only adds to the difficulty. Complete removal of the denuded and inflamed area of cartilage, either by excision or cautery, seems to be necessary to obtain a complete healing.

DR STEVENS (closing) I was in Washington last February [1933] when I first saw some of these cases demonstrated, and I was so impressed with the work that I asked them to present it at this time.²

There are two or three points I would like to emphasize.

First of all I think this work seems to demonstrate what has generally been deemed by physicists and biologists for some time—that there is a selective action of x-rays according to the wave length. I do not say that Dr Rathbone's results prove such a theory, but they present more evidence in favor of such a conception.

Also, that the importance of, first of all, getting rid of as much of the infection as possible before beginning to treat any carcinoma with radiation is an important point.

²See paper by Dr F A Merritt and Dr R R Rathbone in *Radiology*, June 1935, 24, 701-707.

that was originally brought out by Regaud and his collaborators. Their results show the importance of carrying out that technique. Infected tissue is very apt to slough and to give trouble.

Another point is that we must give these cases very large doses of radiation over a long period of time in order to get results.

DR R RHETT RATHBONE (closing) Of the 14 cases I presented,² 11 were private patients and three were clinic cases. That is about the relative percentage. We give private cases the same dose we give clinic patients.

As far as the pain is concerned, we think that the striking difference between this highly filtered radiation and lightly filtered radiation is the mild reaction, and the small amount of pain is well controlled by nupercanol ointment. As Dr Stevens pointed out, we have to be scrupulously careful about keeping the treated areas clean until the lesion is entirely healed, to avoid infection.

As to biopsies taken two or three months after treatment, we have taken no biopsies, as the lesions all healed or looked perfectly healthy except in one case—a year afterward—in which we suspected that we had not completely eradicated the lesion.

We used 20 milliamperes in all cases.

As to neuritis following this treatment, we have had no evidence of the radiation producing nerve injury.

I am very glad Dr Cutler called our attention to adenocystic basal-cell carcinoma. In reviewing some of the pathologic slides with Dr J W Lindsay, our consulting pathologist, he stated that several of the cases were adenocystic basal-cell carcinoma.

As to the accuracy of the dose, I did not mention that we have two Victoreen "r-meters," and check one against the other. One of them was checked at the Bureau of Standards this Fall, so we are certain we are giving these tremendous doses.

As for the reaction on the mucosa in treating lesions about the mouth, we do get

tion. In such cases as the latter the parents should be advised of the probable retardation of growth and differentiation of tissues, not only in the part irradiated but in the most distal part of the same side.

DISCUSSION

DR W. S. LAWRENCE (Memphis) I wish to ask if these were private or ward cases and just to what extent their rebellion went at the height of the reaction caused by the treatment. I would also like to ask if any biopsies were done—say, a month or two after the treatment to see what the final result might be—whether there were any prospects or possibilities of relapse a little later.

I would judge that the Doctor's economic statement was a little low. The actual time of running the tube may not have cost more than the amount stated, but the total overhead for that amount or that number of r would I think be rather excessive.

DR MAX CUTLER (Chicago) I would like to ask Dr. Stevens what the dosage was on the case he treated.

DR STEVENS The child received something over 800 r during 11 days in a preliminary series in November, 1929. In January, 1930, during a period of 21 days she received something over 900 r.

DR CUTLER What was the child's age?

DR STEVENS Four months when we began treatment.

DR CUTLER I think that you have made a very interesting observation. I have a similar problem at the present time with a child four years of age in whom a malignant tumor of the testicle was removed. In considering the question of prophylactic radiation, we are immediately confronted with the same problem. Shall we irradiate the operative site? How can we protect the opposite testicle? What is the castration or sterilization dose and shall we irradiate the retroperitoneal glands prophylactically? It brings up the same problem that Dr. Stevens has brought up.

I should like, also, to comment on Dr. Rathbone's paper.¹

It is my belief that you are not taking quite enough credit for some of these cases that you have called basal cell carcinoma. Several of the cases that you have cured are clearly adenoeystic epitheliomas, and they are far more radioresistant than basal-cell carcinomas.

Finally, I would like to congratulate Dr. Rathbone upon his very important contribution. I do not know of any group of cases in which such large doses of radiation have been used on lesions which have been irradiated previously. It is important to know to what extent a complete irradiation can be executed following previous incomplete radiotherapy. Most radiologists would have hesitated to administer so much radiation to lesions that had been subjected to previous treatment. Dr. Rathbone has given us some very valuable information on this subject.

DR CHARLES V. GENOWAY (Boise, Idaho) I would like to ask the Doctor what milliamperage he used.

DR LAWRENCE May I add one question which I forgot to ask? Have you had any trouble with radiation neuritis or neuralgia in these extreme doses? I recall one case myself that I thought I over-treated. The lesion was all gone. It was in the region of the parotid gland. Nothing was wrong with the skin—everything looked fine—there was no lump left, and I thought the patient was well. A few weeks later—or a month or so later—the patient developed extreme pain in that region—neuritis or neuralgia or something of the sort.

I have read of a good many cases of extreme pain in the axillary nerves from the implantation of radium too close to the nerve, and this, it seems to me, would be about as much radiation as you would get from interstitial radiation by radium.

¹ The Treatment of Epithelioma Involving Cartilage Using 220 K V P and Heavy Filtration. E. A. Merritt and R. Rhett Rathbone. *RADIOLOGY* 1935 24, 701-707.

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the usual diphtheric membrane, which seems to be more painful than the skin reactions. To protect the tongue and alveolar mucosa we place a millimeter of lead covered with red dental rubber between the teeth and the cheek.

The total number of cases treated so far is small, but the rapid, relatively painless healing of these lesions involving cartilage is most gratifying and the results are superior to the methods we have used previously.

FURTHER DISCUSSION OF THE RELATIONS OF THE ANTRUM AND CAP TO THE GALL BLADDER AS FACTORS IN EMPTYING THE GALL BLADDER¹

By NATHAN B. NEWCOMER, M.D., and ELIZABETH NEWCOMER, M.D.,
Denver, Colorado

THE function of the gall bladder is to receive, store, and concentrate the bile, to act as an equalizer of pressure in the biliary system, and to deliver the bile periodically into the duodenum during early digestion. The gall bladder empties through the cystic duct into the common duct, and thence into the duodenum. It may empty normally in small quantities when the stomach is empty.

In routine visualization of the gall bladder, we noticed that its location varied within wide limits in the different types of habitus, and that the extremes were more apt to have gall-bladder disease. When a barium meal was given, the position of the pyloric antrum and duodenal cap varied in a similar manner. Often, we visualized the gall bladder by the dye test and the stomach by the barium meal at the same time.



Fig 1 Tracings of x-ray films of the same person (I) visualized gall bladder, stomach empty, (II) visualized gall bladder, stomach filled with solid meal (note change in shape and position after eating a solid meal), (III) visualized gall bladder, stomach filled with barium and buttermilk. Note that the gall bladder lies nearer the mid line and lower with the liquid meal than with the solid meal.

Before the epochal discovery by Graham and Cole, which allowed visualization of the gall bladder in man, our knowledge of the location and behavior of the human gall bladder in the living was limited. We knew that a flattened or crescentic indentation shown on the duodenal cap or stomach probably meant a pathologic gall bladder, and also that a long, narrow, rigid antrum which did not expand during peristalsis generally indicated gall-bladder pathology. Also, that overweight and underweight, pregnancy, fibroids, and abdominal tumors predisposed to gall-bladder pathology.

Normally, the gall bladder, antrum, and cap were in close contact, generally, when they were not, pathology was present in the gall bladder. Routinely, we made a mark on the patient's right side half way between the crest of the ilium and the ribs and half way between the vertebral column and the side of his body, focussing through this point. The dye was given intravenously and a film taken in six hours, before eating. A second film was taken an hour after eating. We noticed that if the gall bladder was normal it moved upward and outward from one to two inches after eating, and had a flattened or curved indentation on the side next to the antrum and cap, particularly during a peristaltic wave of the

¹ Read before the Midsummer Radiological Conference in the Rocky Mountains, sponsored by the Denver Radiological Club Aug 28-30, 1935.

antrum. If the gall bladder did not move upward and outward, it was practically always diseased and would not empty even

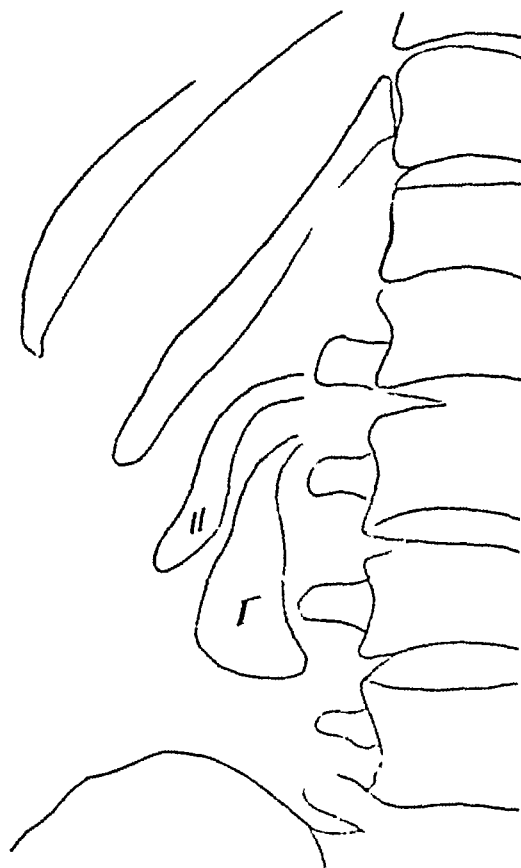


Fig 2 Tracings of x-ray films showing the change in shape and position of the same gall bladder, (I) before eating, (II) after eating

in 24 hours. If there was a crescentic indentation on the cap, the gall bladder was diseased. Occasionally, a gall bladder would not visualize before eating but would visualize immediately after eating and empty in 24 hours. Many gall bladders visualize, are light in density, and will not empty in 24 hours; others visualize, are normal in density, but will not empty in 24 hours.

An effort to explain these variations led us to study the anatomic relations of the stomach, duodenum, and gall bladder, and also to study the literature as to the factors concerned in the emptying of the gall bladder.

There were a great many confusing and

conflicting ideas as to the factors concerned and especially in regard to the following: muscular development of the gall bladder and the efficiency and nature of its contractions, elastic recoil, respiration, engorgement of the liver, dilution and interchange of bile in the gall bladder and reciprocal action with the sphincter of Oddi, a gall-bladder hormone, and gastric and duodenal peristalsis. A short review of the known facts is as follows:

McMaster and Elman state: "The discharge of bile into the duodenum may be thought of as chiefly dependent upon three factors: the tonus of the muscles about the lower common duct, the activity of the gall bladder, and the pressure of the bile secretion."

The sphincter of Oddi at the outlet of the common duct and the intramural mechanism interpose a moderate barrier to the continuous passage of bile into the duodenum, thus allowing the gall bladder to fill. When the action of the sphincter is destroyed by inserting a cannula or by other means, the gall bladder does not fill, when the gall bladder is absent or occluded or removed by surgery, the secretory pressure overcomes the sphincter and bile passes continuously into the duodenum. Without this sphincter, there would be little or no pressure in the biliary tract.

There would be no pressure in the biliary system if it were not for secretory pressure. The secretion of bile is more or less continuous but is more active during gastric digestion. The gall bladder concentrates the bile by removing the liquid constituents between periods of digestion, and thus reduces the pressure due to secretion below the threshold of the sphincter of Oddi.

The resistance to the passage of bile into the duodenum varies with the tone of the sphincter, which may be increased or decreased by a great many different things. The sphincter is a type of involuntary muscle subject to nerve control. It is also subject to involuntary muscle stimulants and depressants, to mechanical, chemical, and local stimulants. It is affected by the general body condition, duodenal peristal

sis, mechanical distention by air, water, food, etc., by the amount of pressure in the connected with the gall bladder, suggesting a discharge of bile contents

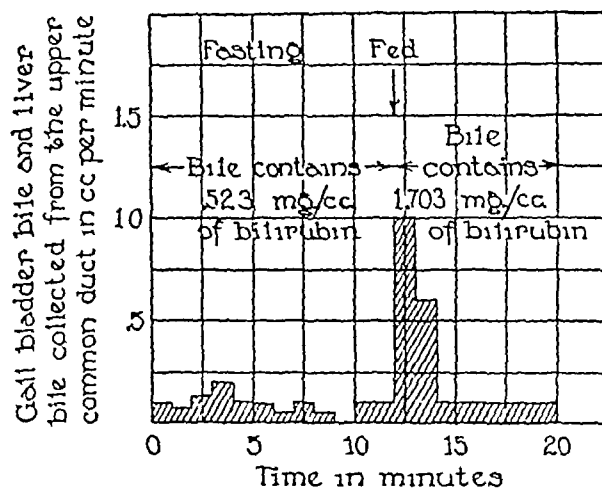


Fig 3 Food as a stimulus to the discharge of bile from the gall bladder. Bile was collected from the upper common duct, draining both liver and gall bladder. The gall-bladder connections had been left undisturbed. When food was given, a large amount of viscid and highly pigmented bile was voided practically at once. The differences in the amount and nature of the bile collected point to a discharge of bile from the gall bladder. (This graph is taken from Philip D McMaster, M D and Robert Elman, M D Jour Exp Med 1926 44, 173.)

bile duct system, and the presence or absence of food in the stomach and cap

In regard to secretory pressure and pressure in the common bile duct and gall bladder, we quote further from McMaster and Elman from their experimental work on dogs. These experiments are quite convincing and generally quoted

"To determine secretory pressure, it is necessary to exclude the gall bladder as absorption of the fluids by the gall bladder occurs rapidly, in dogs, it has been found by various observers to be from 200 to 320 mm of bile when all outlets have been excluded. The rate of secretion does not vary until the maximum pressure is reached, when it stops at once

"With the gall bladder excluded, and while the bile was being collected, the animals were allowed to eat bread, milk, and meat mixture for from two and one-half to three minutes. No change in the rate of secretion occurred in the first 5 to 15 minutes, then a gradual progressive increase occurred, but the amount of bile secreted returned to normal in about 45 minutes

With the gall bladder undisturbed, and immediately after the first swallows of food, an abundant gush of far darker and more viscid bile suddenly flowed into the graduate

"From 60 to 70 mm of pressure causes bile to enter the gall bladder in the anesthetized dog and 100 mm in the unanesthetized dog. The resistance to the passage of bile through the common duct sphincter in the normal animal fed 4 to 12 hours previously is sufficient to support a column of bile from 100 to 120 mm in height, and in the fasting animal from 250 to 300 mm high. The resistance is lowered from 50 to 80 mm immediately after taking food and later during digestion

"Food was given to a dog for two minutes after it had been fasting 30 hours. Five to 10 seconds after swallowing, the bile column began to rise, and in 45 seconds bile was forced into the collecting graduate against the 200 mm of pressure and continued to flow for 45 seconds more. The animal was again allowed to eat for two and one-half minutes, consuming 150 grams. Almost at once the bile column rose to over 200 mm and returned again slowly to its previous level, until 8 minutes later it had gone to 115 mm and there it remained. Seventeen minutes later, food was again offered, and the bile rose above the 250 mm level

"In these experiments, there was no sudden gush of bile from the liver, the increase in bile secretion after feeding being very gradual, but the abrupt rise in the column of bile in the manometer connected with the gall bladder



Fig. 4

Fig. 5

Fig. 6

Fig. 4 A gall bladder visualized by the intravenous method at six hours. Note the relation of the gall bladder to the liver, and the oblique angle of the lower border of the liver. Note also the shape of the gall bladder and the pendulous position before a meal is taken.

Fig. 5 The same individual, 15 minutes after a liquid meal. Note the relation of the antrum and cap to the gall bladder. Note the flattening of the gall bladder during peristalsis. This is not a contraction, it is the direct pressure of the antrum and cap against the gall bladder.

Fig. 6 The same individual, 20 minutes after a liquid meal. The gall bladder appears relaxed in the absence of peristalsis of the antrum.

could therefore have been due only to pressure within the viscus.

In several experiments, the rhythmic recurrence of abrupt increases in pressure within the gall bladder in the absence of any further ingestion of food rules out the possibility that a generalized increase of intra abdominal pressure was the direct cause of the phenomenon.

The secretion of bile is increased greatest by proteids, less by fats, and not at all by carbohydrates. It is also increased by certain drugs and other substances (secretin).

MUSCULAR DEVELOPMENT OF THE GALL BLADDER AND THE EFFICIENCY AND NATURE OF ITS CONTRACTIONS

Gray's Anatomy states

"The fibro-muscular coat, a thin but strong layer forming the framework of the sac, consists of dense fibrous tissue, which interlaces in all directions, and is mixed with plain muscular fibers, disposed chiefly in longitudinal direction, a few running transversely."

Characteristics of plain, smooth, or involuntary muscle are as follows, quoted from Starling

"The physiologic properties of plain muscle differ with its source. Plain or smooth muscle is distinguished from voluntary muscle not only by its histologic structure, its chemistry,

its innervation, and its physical properties, but especially by the phenomena of independent tonus and rhythmic contraction.

"In case of smooth muscle, there is a double nerve supply, one variety being motor and the other inhibitory.

"The physiologic significance of the double nerve supply is evident from the fact that, even when deprived of all nerves, plain muscle may exhibit either sustained spontaneous contractions, known as tonic, or else intermittent rhythmic contractions, so that control of both contraction and relaxation is essential.

"The strength and frequency of these rhythmic contractions vary much according to conditions, in some types of plain muscle, they are quite regular, frequent, and powerful, whereas, in other cases they are slow, often irregular, and of variable or negligible amplitude.

"Plain muscle also reacts to chemical stimulation. Many drugs such as eserine, salts of lead and barium, histamine, acetyl choline, pilocarpin may cause contraction. The action of these drugs varies from organ to organ, and some of them such as eserine, barium salts, and perhaps pituitrin appear to act directly on the muscle cells, while others, as adrenaline, exert their action on the accompanying nerves or their endings. Accordingly, adrenaline may cause either relaxation or contraction.

"Smooth muscle is also very sensitive to mechanical stimulation, and the most important form of this is that produced by tension. The effect of increasing the tension on smooth muscle may be twofold causing in the first

place extension, and, in the second, excitation with increased contraction

"A peculiar property of plain muscle is that a stimulus (electrical or mechanical), which, when applied to the relaxed muscle, causes a contraction, will, when applied to the tonically contracted muscle, often provoke a rapid relaxation, and *vice versa*. This also holds true for nerves supplying the plain muscle, and may be the cause of rhythmic contractions when the muscle is slightly stretched "

The gall bladder contains smooth muscle and elastic tissue, and is subject to nervous control, but fills and empties when completely denervated. Like other involuntary muscle, it is affected by certain drugs and electrical and mechanical stimulation. It is subject to increases of pressure exerted by adjacent organs, as the liver, stomach, intestines, respiratory movements, etc. Also many drugs which increase the secretion of the bile will have a definite effect on the tension of the gall bladder.

CONTRACTIONS OF THE GALL BLADDER AS SEEN IN ANIMALS AND MAN (TAKEN FROM IVY)

In Animals—'Genuine contractions have been recorded from the gall bladder *in situ*, in both anesthetized and unanesthetized animals, chiefly in the dog, and from 'strips' of the gall-bladder wall.

"The motility of the gall bladder in the dog is of two types: first, a tonic contraction of the musculature which causes a prolonged increase in intra-gall-bladder pressure, lasting from 5 to 30 minutes or more, and second, a tonus rhythm, in which the gall bladder contracts and relaxes at a rate of from two to six times per minute. In each type, the musculature as a whole or a portion of it may contract. The tonic contraction may lead to a maximum rise in intra-gall-bladder pressure of from 20 to 30 cm. of bile with the cystic duct obstructed."

Winkelstein and Aschner state "The musculature of the gall bladder displays tonus variations but seems to possess little contractile power. No evidence was found of spontaneous contractions of the gall bladder in the dog either under anesthesia or when fully recovered."

Okada and Levine both record rhythmic contractions of the gall bladder.

Sachs, Howard, and Barry state "That gall-bladder contractions exist can hardly

be questioned, it is hard to believe that it alone can account for expulsion of the gall-bladder contents, and, in our opinion, it is only one of the factors which assist in this process." Freeze concluded that the maximum force of contraction of the bladder does not much exceed the maximum secretion pressure as determined by Heidenhain.

A careful study of the literature leaves no doubt that the gall bladder contracts, but there is considerable skepticism among many competent observers as to the efficiency of this contraction in emptying the gall bladder. Of necessity, any expansile vesicle must have power of contraction, otherwise it could not adjust itself to its variable content. If the sphincter of Oddi is sufficiently relaxed, the contraction of the gall bladder might aid in evacuation. It is extremely doubtful if the contractions exert enough force to overcome the normal tone of the sphincter and empty the gall bladder in the manner and the time at which it is known to empty.

In Man—Very few observers claim to have seen actual contractions of the exposed gall bladder in man.

Moynihan states "I have watched the gall bladder many hundreds of times during operation, and have never seen anything approaching a tonic or peristaltic contraction. Very rarely one does see evidence of life."

Ivy cites Bassler, Luckett, and Lutz as not observing contraction of the gall bladder at laparotomy after the instillation of magnesium sulphate into the duodenum. He quotes Pribam as observing a "distinct" contraction associated with evacuation after instilling Witte's peptone into the duodenum. He also quotes Kalk (using the method of intra-abdominal endoscopy and injecting pituitrin subcutaneously) as observing the gall bladder gradually decrease to one-half its original size, manifesting tonic contraction but no sudden contraction or peristaltic waves.

Matsuo reports two cases in which the abdomen was open and the gall bladder under direct observation. In the one case,

in which the duodenal tube was inserted two hours before operation, the abdomen was opened under local anesthesia and the gall bladder was observed as large as a goose egg. $MgSO_4$ was instilled into the duodenum through the tube. He did not see the so called contraction nor did the gall bladder collapse like a balloon from which the air was released as in the case reported by Dr Sachs. The gall bladder decreased to one-fourth its size in an instant after instillation of magnesium sulphate.

In the second case reported by Matsuo under the same conditions in which, after the gall bladder was exposed and when bile ceased to flow $MgSO_4$ was introduced. The bile did not flow as the olive was not in place. He replaced the tip and then introduced 35 c.c. of a 1 per cent azorubin S solution into the gall bladder and red bile ran out. He then instilled $MgSO_4$ through the tube and 15 c.c. of bile ran out in the first five minutes, 42 c.c. in the next five. At this time, the gall bladder became small although nothing like a contraction could be observed.

This is not a very convincing array of evidence of an actively contracting gall bladder evacuating its contents through the intrinsic action of its own musculature. The instillation of $MgSO_4$ into the duodenum undoubtedly lowers or destroys the tone of the sphincter, enabling the gall bladder to evacuate because of lack of resistance of the sphincter instead of by active purposeful muscular action of the gall bladder.

DISCUSSION OF TERMS USED

Much confusion has arisen in the gall-bladder literature because of the use of inexact terms by some authors. The term "contraction of the gall bladder" is often used when evacuation or emptying of the gall bladder is all that has occurred, again in some cases, the term "contraction" is used when decrease in size or a collapse of the gall bladder is meant. Some authors reason that the changes in size and shape of the gall bladder seen in x-ray films can only be due to contraction and conse-

quently term the changes, "contractions." Some do not differentiate between general changes in intra-abdominal pressure and local pressure. Pressure fluctuations in the gall bladder registered by different methods are often termed "contractions." It is often necessary, when reading an article in which some author is quoted, to secure the original article to determine exactly what is meant.

DISCUSSION OF VARIOUS FACTORS WHICH CAUSE EVACUATION OF THE GALL BLADDER

Experiments by many establish the fact that various apparently unconnected factors will at least partially empty the gall bladder, some of which are enumerated. Fear, anger, excitement, smell of food, hunger pains, tube inserted into the stomach or duodenum, breathing, vomiting or straining, peristalsis of the stomach and duodenum, shaving the legs, skin incisions, intravenous of blood, cross-circulation, insulin, water by mouth, and various substances introduced into the duodenum through a tube, also, $MgSO_4$ by way of the stomach, or into the duodenum through the tube besides many other drugs. Ivy reports that the hormone "cholecystokinin" will empty the gall bladder. But above all, food in the stomach is the normal method of emptying the gall bladder. Many claim that fats are essential, but a normal meal will empty a normal gall bladder (Figs 19 and 20).

EFFECTS OF FOOD

The ultimate function of the gall bladder is to deliver the stored and concentrated bile into the duodenum early in digestion. Boyden discovered that egg yolk and cream would completely empty the gall bladder, and based most of his experiments on a meal of five egg yolks and half a pint of cream. However, a normal gall bladder should empty after a normal meal of meat, bread and butter, potatoes, etc. We have seldom if ever used any other meal for emptying the gall bladder since we started to use the dye test except for experimental purposes. We believe this is a better test



Fig 7

Fig 8

Fig 9

Fig 7 The same individual as in Figures 4 5 and 6 25 minutes after a liquid meal The gall bladder is relaxed The peristaltic wave of the antrum has not contacted the gall bladder

Fig 8 The same individual after a solid meal was given Note the increased distance of the antrum to the right with a solid meal and the more intimate contact of the antrum and cap with the gall bladder Also the marked reduction in size of the gall bladder as the antrum and cap press it against the liver

Fig 9 The same individual 45 minutes after the solid meal Note how much larger the antrum is, and how much farther it is pushed to the right with a solid meal than with a liquid meal

of the ability of the gall bladder to empty under normal conditions than the egg yolk and cream mixture

Great credit should be given Dr Boyden for his persistent, open-minded, and careful investigation of the gall-bladder problem in man and animals We are quoting a short review of the results of his experiments He divides the reaction of the gall bladder to foods into four periods (1) initial response, (2) the two-minute pause, (3) the principal period of discharge, (4) succeeding phases of contraction

The Initial Response—Perhaps the most striking feature of the reaction of the gall bladder to food is the very short latent period of contraction, 14 out of 17 patients showed a marked diminution of volume within the first two minutes after food entered the mouth Since fluoroscopic observation indicates that the head of a meal of egg yolk passes the pylorus a few seconds after deglutition, the latent period of the human gall bladder is therefore established as approximately one minute after egg yolk enters the duodenum (McMaster and Elman showed the latent period for the gall bladder of the dog to be exactly the same)

A second observation that can be made about this first period of contraction is that the diminution of volume in the first two minutes is usually greater than that of any subsequent two minutes—an average of 51 c.c. as compared with 31 c.c. in the ten cases

The Two-minute Pause—At the end of the first two minutes, the descent of the curve is abruptly checked and is not resumed again until at least two minutes later This is a very characteristic and significant feature in the emptying of the human gall bladder, as it has occurred exactly at this point in 12 out of the 17 cases

The Principal Period of Discharge—By this phrase is meant that portion of the first phase which results in the greatest discharge of bladder bile It follows immediately after the two preliminary features already noted—'initial response, and the two-minute pause,' and ends anywhere from 16 to 60 minutes *postcibum* In the last 17 cases, its average duration was 32 minutes, during which time the contents of the gall bladder (excluding the neck) was reduced approximately three-fourths of its volume From these data it must be apparent that the first phase is the most significant portion of the cycle of emptying and filling, for by means of this a large amount of concentrated bile is poured into the duodenum during the first part of a meal

Succeeding Phases of Contraction—Following the termination of the first active phase, the gall bladder is generally quiescent for a short period, varying from 5 to 45 minutes Then comes the second phase of contraction, frequently followed by several alternating periods of relaxation and contraction, until eventually the gall bladder is emptied

It may be noted that the phases of contraction subsequent to the first are more or less irregular and not sharply defined Moreover, they are less important, since one-half to three-

fourths of the contents of the gall bladder has already been discharged. Since the organ is no longer distended, the expulsion of bile is much slower, especially toward the last. It sometimes happens that the gall bladder is sometimes emptied by the first or second phase of contraction but in the majority of cases it takes three or four phases.

VIDEORADIOGRAPHY SUGGESTING REGULATORY ACTION ON THE SPHINCTER MECHANISM AT THE OUTLET OF THE COMMON DUCT IN MAN

"In any discussion of the mechanism of the flow of bile, two factors are of prime importance—the force which expels the bile from the gall bladder, and the method by which the flow of bile is regulated. Since the evidence now seems conclusive that the musculature of the gall bladder is responsible for the expulsion of the contents of the organ, it is possible for the flow of bile to be regulated in only two ways—either exclusively through the activation or inhibition of this expelling musculature, or by the addition to this of a supplementary mechanism which controls the flow of bile at the outlet of the common duct.

"*The Two Minute Pause*—A second line of evidence, suggesting a dual control of the flow of bile, is offered by the existence of the peculiar irregularity in the curve of the first phase of contraction, which has been previously designated as the two minute pause. When it became clear that this was a fairly constant feature, the question arose as to why the flow of bladder bile should be temporarily checked at the end of the first two minutes. The matter was further complicated by the observation that the *shape of the gall bladder during the 'two minute pause' did not indicate relaxation, but rather continued contraction*. Coupled with this was the interesting fact that the reduction of gall bladder volume was greater in the first two minutes than any subsequent two minutes. The implication was that the irregularity in the curve was due to the action of the duodenal sphincter, and not to the gall bladder, that, following the ingestion of food, the orifice of the common duct was suddenly opened, permitting the gall bladder to fill the extra-hepatic duct system without hindrance, and that, two minutes later, renewed closure of the orifice checked the flow of bile from the gall bladder temporarily, even though the latter continued to contract.

"Simultaneously with the ingestion of food, there is a drop in the resistance of the sphincter. Approximately a minute later, the gall bladder begins to contract. As a third step in the sequence of events, the resistance offered by the sphincter suddenly increases, beginning two minutes after the ingestion of food, and

continuing until it is greater than the force exerted by the gall bladder.

"The striking agreement of these data with the observations recorded by the writer seems to afford the most satisfactory basis for interpreting the contraction curves of the human gall bladder."

He cites a case in which small amounts of egg yolk were injected directly into the duodenum at intervals.

"After each injection, the gall bladder immediately 'contracted'. This series emphasizes three facts. First, that the initial effect is greater when egg yolk is introduced directly into the duodenum than when taken by mouth, secondly, that a food stimulus is most effective when applied to a distended gall bladder, and thirdly, that the mechanism of contraction is a trigger mechanism set off by a variety of fatty foods, and that the entrance into the intestine of each dose of an effective food results in a single phase of emptying which is immediately followed by filling. Incidentally, it shows that one egg yolk is not sufficient, but that enough must be eaten to insure sufficient spurts of yolk-laden chyme to induce the number of successive phases required to empty the gall bladder, and the right kinds of fatty foods must be chosen to completely empty the gall bladder.

SPHINCTER TONE

There is no question but that the tone of the sphincter is an important factor in emptying the gall bladder. In a fasting dog, the sphincter will support a column of water 250 to 300 mm in height, in the normal animal fed 4 to 12 hours previously, 100 to 120 millimeters. After taking food and again later during the process of digestion, the resistance of the sphincter is lowered from 50 to 80 millimeters.

Many substances injected directly into the duodenum relax the sphincter. Several factors enter into their action. Boyden states

"The Rehfuess tube in the stomach caused marked emptying of the gall bladder, 16 to 18 c.c. The smelling of food, distention of the duodenum with air, and drinking of water, all produced the 'initial response' induced by ingestion of food. Injecting 30 c.c. of HCl, 50 to 75 degrees acidity, into the duodenum produced immediate contraction and diminution of the gall-bladder volume followed by filling. $MgSO_4$, $MgCl_2$ and Na_2SO_4 injected

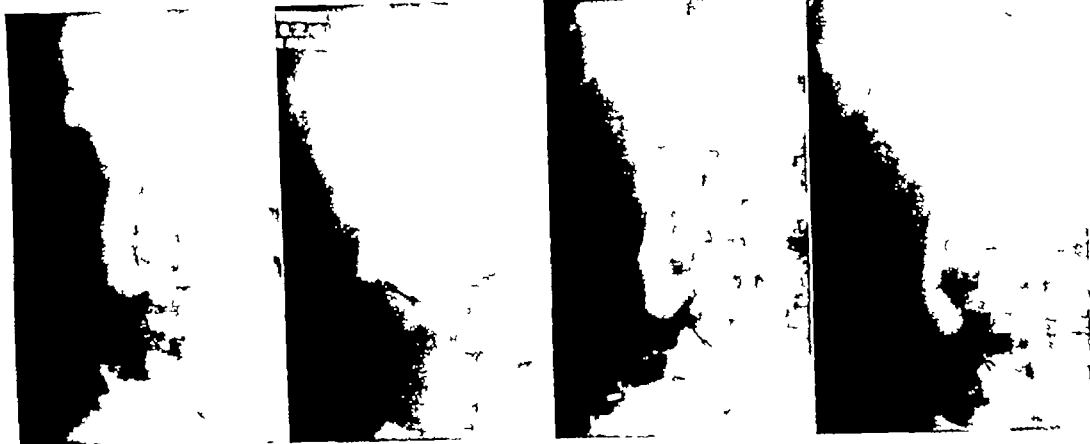


Fig 10

Fig 11

Fig 12

Fig 13

Fig 10 A visualized gall bladder Note its position and shape when the stomach is empty

Fig 11 Note the change in size, shape and position of the same gall bladder after the administration of a solid meal This gall bladder was entirely empty in 24 hours Note the shifting upward and to the right, due to the pressure of the filled stomach Note the change in shape which is due to pressure, and not to a contraction of the gall bladder

Fig 12 A visualized gall bladder by the intravenous method at six hours (before eating) Asthenic habitus Note shape and location of the gall bladder

Fig 13 The same gall bladder after administration of a solid meal Note that there is practically no change in size, shape, or position It does not move upward and outward after eating This gall bladder did not empty in 24 hours

into the duodenum, in 5 out of 8 cases emptied the gall bladder two-thirds within 40 minutes "

Obviously as Boyden says,

"They also open the intestinal orifice of the gall bladder or the bile could not escape "

Matsuo (in man) with the abdomen open, the gall bladder exposed, and the duodenal tube in place, after instillation of 40 c c of 33 per cent $MgSO_4$, states "Two minutes afterward bile began to flow out, 45 c c was recovered in the first five minutes, and 42 c c in the next five minutes At this time the gall bladder became small, although nothing like contraction could be observed to be taking place " This indicates a relaxation of the sphincter

Ivy and Oldberg report on contraction of the gall bladder with HCl in the duodenum ten experiments with the cystic duct clamped and the gall bladder cannulated under barbital anesthesia Ten to 40 c c of N/10 HCl were introduced into the duodenum with needle and syringe They observed contraction of the gall bladder (judged by a rise of bile in the cannula) in every instance The minimal quantity needed to elicit a response was 15 cubic centimeters

"The injection of the following substances into the duodenum of the dog caused the gall bladder to contract with the animal under light barbital anesthesia Fifteen to 40 c c of N/10 HCl, 30 c c of butter, digested egg yolk, cream and olive oil, 0.5 per cent butyric acid, and 5 per cent soap solution Undigested olive oil, egg yolk, and cream were ineffectual "

We quote from Winkelstein and Aschner as follows "Various agents (notably substances present in gastric chyme and $MgSO_4$), when placed on the papilla of Vater, lessen somewhat the tonus of the sphincter of Oddi but usually not more than one-fifth to one-sixth of the original figure "

Certain drugs have a depressant action on the sphincter All drugs that cause a fall in blood pressure cause the gall bladder to empty

Winkelstein and Aschner say further "Of the drugs acting on the vegetative nervous system, atropin decreases and pilocarpin increases the tonus of both the gall bladder and the sphincter of Oddi Adrenalin decreases the tonus of the sphincter "

Okada has shown that adrenalin relaxes



Fig 14



Fig 15



Fig 16

Fig 14 This gall bladder is visualized very light in density, spherical in shape. It lies farther from the midline than normal.

Fig 15 Same case as Figure 14 after taking a solid meal. The gall bladder shifted upward and outward. The cystic duct and common duct are visualized, which is very unusual. The gall bladder is flattened. Many investigators would state that this is due to a contraction of the gall bladder. We believe it is due to pressure of the antrum and cap.

Fig 16 Same case. Shows the marked excursion of the stomach during peristalsis and a markedly deformed cap. A comparison with film Figure 15 showing that the antrum contacts the gall bladder intimately, even in its abnormal location. This gall bladder does not fill normally until the cystic duct is straightened by the pressure of a solid meal. It empties in 24 hours in spite of its abnormal location.

the sphincter when injected intravenously. Boyden says the intravenous injection of adrenalin causes a greater expulsion of iodized oil from the gall bladder than any other agent. Alvarez says, "The action of adrenalin on the intestinal muscle is a purely depressant one."

Duodenal peristalsis is a factor in the control of the sphincter. Ivy states: "The relationship between the sphincter of Oddi and duodenal peristalsis has been described as follows by Giordano and Mann, and also by Puestow, bile may spurt from the papillary orifice without evident peristalsis, but if peristaltic waves are present, the outflow will occur with the peristalsis. The author (Ivy) interprets the evidence as strongly indicating that in those species which possess a gall bladder, the common duct possesses a special sphincteric mechanism, which is intimately co-ordinated with duodenal tone and peristalsis, but which may also function independently."

Starling states: "The sphincter of Oddi is competent to close the entrance of the bile duct into the duodenum when the pressure is low, and its action is further aided by contraction of the muscular wall of the duodenum itself."

Hunger pains are due to peristalsis and empty the gall bladder partially, as proven by Boyden.

The sight of food, hunger pains, the tube in the stomach or duodenum, water by mouth, air in the duodenum, egg yolks, $MgSO_4$, and HCl in the duodenum all empty the gall bladder partially. What are the principles underlying the actions of these varied substances on the sphincter of Oddi? Water, air, hunger pains, and $MgSO_4$ could hardly produce a hormone. They all produce peristalsis. Mechanical dilatation of the duodenum is a factor in most of them, and mechanical dilatation produces and increases peristalsis. That the amount of distention of the duodenum is a factor is

shown by Ivy's statement that from 15 to 30 c c will empty the gall bladder but that less than 15 c c will not do so

intestinal tract is largely autonomous, that is, it carries within itself the mechanism essential to peristalsis "



Fig 17

Fig 18

Fig 17 Visualized gall bladder in boy of 15 years. Intravenous method. Antrum and cap were deformed in the gastric films. This is the six hour film, showing the gall bladder to be large and light in density. It lies too near the mid line. The seven hour film (after eating) was not taken because of the patient's condition.

Fig 18 Same case as Figure 17, 24-hour film, showing the gall bladder denser than at six hours. This boy had his gall bladder removed with complete relief of symptoms.

Also Boyden states that 30 c c of one egg yolk and water injected into the duodenum will produce a greater initial effect than when taken by mouth. The fact that Winkelstein and Aschner noted only a slight reduction of sphincter tone when applying known sphincter depressants locally shows the absence of the additional factor of mechanical distention.

The passage of food into the duodenum also causes distention of the duodenum.

Alvarez states 'The duodenal cap tends to remain filled during the early stages of digestion'. Also, 'Most of the motor activities of the stomach and bowels are brought about and regulated largely by the internal pressure due to food'. Further 'It is clear then, that the gastro-

According to Starling, "The normal pressure in the duodenum is about 150 mm of water, and the pyloric intragastric pressure 100 mm during relaxation, and from 200 to 300 mm during an intensive wave."

GASTRIC PERISTALSIS

Alvarez states "In the human stomach, waves appear about once in twenty seconds.

On the lesser curvature the amplitude is very small, and in the antrum it is large. The peculiar form of the contraction curve exhibited by the muscle in the pyloric antrum was observed even in the frog."

Quoting from Templeton and Johnson on hunger contractions "Unlike the contractions in the upper portion of the stomach,



Fig. 19

Fig. 19 Gall bladder visualized by the oral method. Buttermilk and barium were given. This negative was taken 15 minutes after eating. Gall bladder emptied in 20 minutes.



Fig. 20

Fig. 20 Same individual as in Figure 19. Gall bladder visualized by the oral method. Cream eggs and barium were given. This negative was taken at 21 minutes. Gall bladder emptied in 1 hour and 15 minutes. Neither egg nor cream is necessary to empty the gall bladder. The commercial buttermilk contains scarcely a trace of fat.

that seen nearest the pylorus is not preceded by a rise in tone. The contraction is sudden and sharp."

Birch and Boyden state "(1) Faradic stimulation of the pars pylorica of the stomach induces sudden contraction of the relaxed gall bladder and ejection of bile into the cystic duct. (2) Hunger contractions of the stomach occur synchronously with rhythmic contractions of the gall bladder, and probably account for the periodic emptying of the gall bladder during fasting."

We do not believe that reflex contraction of the gall bladder is the correct explanation, because repeated observers (including Boyden himself) state that the gall bladder will empty when food is taken, even after the gall bladder has been completely denervated.

MECHANICAL PROBLEMS AS FACTORS IN THE EVACUATION OF THE GALL BLADDER

A careful study of the mechanical features entering into the relations of the liver, gall bladder, cystic and common ducts, antrum of the stomach and duodenal cap, and

the changes in their relations upon taking a meal, also the further effect on these relations during gastro-duodenal peristalsis, reveals the fact that they cannot help but produce localized increase in pressure on the gall bladder and play a distinct rôle in emptying it.

To get a proper understanding of the position and mobility of the liver, we will quote from Cunningham's Anatomy, "Posterior Area of the Parietal Surface" (p. 1117). (1) "The uncovered area of the right lobe is a considerable portion of the back of the right lobe—varying from one and one-half to two and one-half inches in width, and from three to four inches in transverse measurement—which corresponds to the interval between the two layers of the coronary ligament, and is devoid of peritoneum. Over this uncovered portion, which looks more inward than backward, the liver and diaphragm are in perfect contact, and are united by areolar tissue, here too is established a communication by small veins between the portal circulation of the liver and the systemic circulation of the diaphragm."

Piersol states the following in regard to the liver

"The structures most potent in holding it in its proper position are, in the order of their importance (a) the attachment of the hepatic veins to the inferior vena cava, (b) the coronary ligaments and the cellulovascular bands in and between its layers, (c) the fibrous tissue near the vena cava and on the non-peritoneal posterior surface of the right lobe, (d) the muscular wall of the abdomen (keeping the intestinal mass pressed upward beneath the liver), and (e) the lateral and 'suspensory' ligaments

"Coincidentally, with the descent of the viscus, it undergoes a rotation of tilting forward so that its diaphragmatic surface is in contact with the abdominal wall"

This peculiar attachment allows a combination of upward and downward, and inward and outward displacement which is accompanied by rotation. The actual position of the liver and its attached gall bladder varies markedly with the habitus, from the sthenic to the asthenic type, changes in body weight, presence of ascites, pregnancy, uterine or ovarian tumors, etc. It undergoes a similar change in position in passing from an empty stomach to a full meal

We wish to quote from Gray's Anatomy to call attention to the exact anatomic relationships of the antrum, pylorus, and duodenum, to the gall bladder and the liver during the fasting stage and after a meal

The Stomach (The Pyloric Orifice)—Its position varies with the movements of the stomach. When the stomach is empty the pylorus is situated just to the right of the median line of the body, on a level with the upper border of the first lumbar vertebra. As the stomach becomes distended the pylorus moves to the right, and in a fully distended stomach may be situated two or three inches to the right of the median line

Alterations in Position—When the stomach is distended, its surfaces, which are flattened when the organ is empty, become convex. The greater curvature is elevated and carried forward, so that the anterior surface is turned more or less upward and the posterior surface downward, and the stomach brought well against the anterior wall of the abdomen

When the stomach becomes distended the change in position of the pylorus is very con-

siderable, it is shifted to the right, some two or three inches from the median line, and lies under cover of the liver, near the neck of the gall bladder

"The Small Intestine (The Duodenum)"—In the adult, the course of the duodenum is as follows: commencing at the pylorus, the direction of the first portion depends upon the amount of distention of the stomach and therefore upon the position of the pylorus. When the stomach is empty and the pylorus situated at the right of the upper border of the first lumbar vertebra, it is nearly horizontal and transverse, but when the stomach is distended, in consequence of the alteration of the position of the pylorus to the right, the proximal end of the duodenum also becomes altered in position, while the distal end remains fixed and the direction of this portion of the bowel is now anteroposterior. Whether directed transversely or anteroposteriorly, it reaches the under surface of the liver, where it takes a sharp curve and descends along the right side of the vertebral column, for a variable distance, generally to the body of the fourth lumbar vertebra

"The first or superior portion is very variable in length, but is usually estimated as being about two inches. Beginning at the pylorus, it ends at the neck of the gall bladder. It is the most movable of the four portions. It is almost completely covered by peritoneum derived from the two layers of the lesser omentum, but a small part of its posterior surface near the neck of the gall bladder and the inferior vena cava is uncovered. It is in such close relation with the gall bladder that it is usually found to be stained by bile after death, especially on its anterior surface. It is in relation above and in front with the quadrate lobe of the liver and gall bladder, behind with the gastro-duodenal artery, the common bile duct, and the vena porta, and below with the head of the pancreas

"The Stomach"—The pyloric end for about one inch from the pylorus remains narrow, but to the left of this it bulges forward, forming the antrum pylori which is most distinct at the great curvature. By the increase of the organ in length the antrum is carried a considerable distance to the right beneath the liver—even farther than the pylorus itself—so that the terminal part of the stomach is bent backwards and to the left, in order to reach the pylorus, which latter very rarely passes more than one and one-half or two inches to the right of its normal position, namely, in the empty condition, within half an inch of the middle line

"The Duodenum"—When the stomach is distended, the first inch of the duodenum—which

is movable on account of its peritoneal covering—is carried to the right with the pylorus, and thus brought into line with the second or terminal half, which is always directed backwards. Hence the whole of the first portion of the duodenum is directed backwards when the stomach is full."

THE CYSTIC DUCT AND THE HISTERIAN VALVES

Stanley H. Mentzer states "The cystic duct is not constant in shape in man. In a series of 612 cystic ducts examined at necropsy, only 19 were true S-shaped, 41 were single curves sharply flexed on themselves. In five, the duct was straight."

He quotes Jacobson and Gydesen as asserting that the gall bladder can be distended almost to the bursting point without forcing bile out of the cystic duct, whereas it can be easily emptied by slight longitudinal traction on the duct.

The valves of Heister are projections of mucous membrane into the lumen of the cystic duct. He found no uniformity in their arrangement. In most specimens the leaflets ran in a spiral clock-wise manner partially encircling the duct.

Our interpretation of the mechanical features entering into the evacuation of the gall bladder is as follows:

The peculiar attachment of the liver by its inner and posterior portion allows it to move upward and outward with a rotary motion. This permits accommodation of the abdominal contents to changes in weight or increases in abdominal pressure due to pregnancy, tumors, and to the empty and the filled stomach. The gall bladder, because of its attachment to the liver, undergoes a similar motion. This also accounts for its various locations in the abdomen in asthenic and hypersthenic individuals.

Our interpretation of the action of the cystic duct. It is a hollow fibro-muscular tube lined by a redundant mucous membrane connecting the common duct with a movable organ (the gall bladder attached to the liver). Like any mechanical attachment between movable parts, it must be able to handle the play between them.

After a full meal, the gall bladder is pushed upward and outward from one to two inches by the full stomach and undergoes a certain amount of rotation because of its attachment to the liver. This straightens the cystic duct and allows it to readily empty into the common duct, as stated by Jacobson and Gydesen. We ourselves have repeatedly demonstrated in rabbits and guinea pigs that moderate traction on the gall bladder will straighten the cystic duct and readily empty the gall bladder. When the stomach is empty, the muscular portion of the duct assumes some modification of the S-shape by its own contractibility, and the redundant mucous membrane, if rotated, would assume a spiral shape.

This straightening of the cystic duct caused and accompanied by the pressure of the filled stomach upon the gall bladder and liver, would account for the first period of Boyden, the "initial response" (two minutes) and also for McMaster and Elman's results, the *immediate rising* of bile in the tube attached to the gall bladder, upon taking food (in five to ten seconds). It also explains how the straightening of the cystic duct after eating, allows some gall bladders to fill and empty normally after eating, when they would not fill before eating.

The uppermost portion of the duodenal cap is attached to the neck of the gall bladder and the liver. Most of the antrum and cap are freely movable and undergo a similar change in location because of changes in habitus, etc. The type of peristalsis of the antrum, which has been previously described, carries it up against the gall bladder, pressing it against the liver, and exerting additional pressure sufficient to overcome the sphincter, thus emptying it periodically by spurts. At the same time the passage of food into the duodenum produces distention of the cap, resulting in increased peristalsis and lowering of the tone of the sphincter, as we have seen above. The pressure of the filled stomach, and peristalsis of the antrum and cap exerting pressure on the gall bladder, explain the changes

in shape the gall bladder undergoes after eating and during its emptying. This explanation makes unnecessary the assumption

mechanism eventually comes into play. Apparently duodenal peristalsis is normally initiated by distention of the cap, as



Fig 21



Fig 22

Fig 21 Both the gall bladder and stomach are visualized. The antrum and cap do not contact the gall bladder in such a manner as to exert pressure on the gall bladder against the liver. This gall bladder did not empty in 24 hours.

Fig 22 A gall bladder visualized intravenously. Stomach visualized. Duodenal ulcer. The contact of the antrum and cap with the gall bladder is good; however, in none of the series was there active peristalsis of the antrum. There was a heavy residue in the gall bladder at 24 hours. This patient gave a clearcut ulcer history.

tion of a dual nervous control, one impulse causing the gall bladder to contract, and a synchronous impulse causing the sphincter to relax. Gastro-duodenal peristalsis and emptying of the gall bladder occur when all nerves are severed.

We believe that the mechanical factors enumerated above can explain the emptying of the normal gall bladder in the time and manner in which it is known to empty. Other factors which increase or decrease the secretion of bile, or increase or decrease the muscle tone of the gall bladder or the tone of the sphincter play a minor role in emptying the gall bladder. When the normal processes are interfered with by disease or operation, these minor factors probably are an aid. For instance, when the gall bladder is removed, secretory pressure overcomes the sphincter of Oddi. In gastro-enterostomies, it is quite possible that a similar

gastric waves do not cross the pylorus. If they are not normally started in the cap because of the pyloric stenosis, they must be started in the jejunum at the artificial opening by distention of the food. This might result in a retrograde peristalsis of the cap producing a lowering of the tone of the sphincter or the inactivity of the duodenal cap, because of the closed pylorus might result in a lack of tone of the sphincter. It is extremely doubtful if the gall bladder would remain normal over a long period of time in gastro-enterostomy cases. Kalk and Nissen report 12 cases (12 tests made) six emptied completely after the high fat meal, five showed an emptying and a shrinkage of the gall bladder to one-fourth its original size, one showed no emptying—a rather high percentage of delay in emptying.

Our greatest objection to the hormone

("cholecystokin" of Ivy) theory of evacuation of the gall bladder is the time element McMaster and Elman, and Boyden have clearly demonstrated a rise in gall-bladder pressure and a marked emptying of the gall bladder in from 15 seconds to one minute after taking food. It does not seem possible for food to be absorbed from the duodenum, enter the lacteals, pass through the thoracic duct, enter the circulation, and return to the gall bladder in sufficient quantities to produce a marked contraction in this time, nor would it account for the peculiar manner of delivery of bile described by the above authors.

A successful theory must explain all the known facts. We have reviewed the known facts in gall-bladder evacuation, and have shown how they can all be explained on a mechanical basis.

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THE ROENTGENOLOGIC ASPECTS OF OSTEOMYELITIS OF THE SKULL

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AMONG the numerous diseases of the skull which may engage the attention of the roentgenologist, osteomyelitis is not the least important. In other portions of the skeleton, the condition is foremost among the affections which must be considered when pathologic changes are presented upon the roentgenogram. In the skull, however, it takes a subordinate place, due to the fact that it is not of common occurrence and that it nearly always presents itself as a complication of some primary focus of infection elsewhere. For these reasons, the condition has not attracted or received much attention in roentgenologic literature. Nevertheless, because of its close etiologic association with the cranial sinuses, including the mastoids, the gravity of the disease when well established, and the fact that the roentgenogram affords a graphic although somewhat belated record of the course of events, the subject of osteomyelitis of the skull should engage the serious consideration of the general roentgenologist.

In considering osteomyelitis of the skull, the conventional restrictions of the term, as used elsewhere in the body, to the pyogenic and non-specific infections are accepted, thus excluding syphilitic, tuberculous, actinomycotic, and the rarer forms of osteomyelitis. Furthermore, as is generally understood, the skull in this presentation will be confined to the cranium, more particularly the calvarium, since it is in this location that osteomyelitis is most commonly encountered and most readily demonstrated roentgenologically. As a diagnostic problem, the condition does not give much concern, since its secondary nature and close association with the primary infection renders its roentgenologic recognition comparatively easy. However, since

it may occasionally appear spontaneously and apparently idiopathically, the disease must be given due consideration in the differential diagnosis of lesions involving the skull.

The literature clearly reflects the etiology of the condition since most of the contributions on the subject have appeared in journals devoted to rhinology and otology, thus indicating that the disease most frequently arises from the paranasal sinuses and mastoids, particularly the former. For the most part, only casual references are made to the roentgenologic aspects, and for this reason it would seem desirable to emphasize this phase of osteomyelitis of the skull, and thus bring to the attention of roentgenologists a condition with which he must of necessity be familiar for the proper interpretation of roentgenograms of the head. To fully appreciate the changes to be seen upon the roentgenogram in osteomyelitis of the skull, one must have some knowledge of its etiology, pathology, and clinical manifestations, and for this reason a brief résumé of the modern concepts of the condition is presented.

ETIOLOGY

The etiology of osteomyelitis of the skull permits subdivision, and facilitates discussion of the subject under four distinct headings: (1) paranasal sinus disease, (2) mastoid disease, (3) metastatic or hematogenous spread, (4) skull trauma. By far the most common cause is extension from infection in the paranasal sinuses. The other three etiologic factors are less frequently encountered. Each, however, presents certain distinctive features which make it necessary to consider them individually.

Osteomyelitis Due to Paranasal Sinus Dis-

case—The fact that osteomyelitis of the skull is the least frequent of all complications of paranasal sinus disease is substantiated by Bourger (1). He analyzed a series of 534 complications occurring during the course of sinusitis and found but two instances of osteomyelitis. In the same series, brain abscess developed in 176 patients, purulent meningitis in 170, cavernous sinus thrombosis in 61, and extra-dural abscess in 54. While we cannot quote statistics, it is our impression that Bourger reported a particularly fortunate group, and that Munro (2) was closer to the actual facts when he stated that osteomyelitis accounted for about 3 per cent of the complications of sinus disease.

Infections within the frontal sinuses account for most of the cases developing calvarial osteomyelitis as the result of paranasal sinus disease. In a series of 48 patients with osteomyelitis secondary to sinus infection reported by McKenzie (3), the frontal sinuses were to blame in 45 patients, whereas the maxillary and ethmoidal sinuses were at fault in the remaining three cases. The majority of evidence also indicates that the incidence of osteomyelitis is about the same in chronic sinus disease as in the acute infections.

Much has been written concerning the relationship between operations upon infected sinuses and the development of osteomyelitis. Undoubtedly the trauma of radical sinus surgery may, as Furstenburg (4 and 5) and Wilensky (6 and 7) believe, account for the onset of the disease in some patients. Perhaps injury to the periosteum may be of prime importance. If these facts are true, Dixon's (8) plea for simple incision and drainage in patients with sinus disease is not without merit. It seems to us, however, that operative procedures have little bearing upon the development of osteomyelitis, because of the frequency with which it develops in patients not operated upon, and the number of instances in which the disease is first identified at the time of operation. It seems more than likely that in most patients developing osteomyelitis after operation, the disease was

present, although not recognized, prior to surgical intervention.

From the maxillary sinus, extension occurs, as a rule, to the frontal bone, as in the case reported by Hanson (9). The manner of spread and the type of calvarial involvement is exactly the same as in osteomyelitis from the frontal sinus. The ethmoid and sphenoid sinuses have been reported as the etiologic site in a few cases, the infection usually spreading into the base of the skull.

Osteomyelitis Due to Mastoid Disease—Osteomyelitis of the skull following otitic infection occurs less frequently than in the case of sinus disease. Perhaps the anatomy of the mastoid, and the character of the operations employed in removing all of the pneumatized bone, have some bearing upon its infrequency. As Wilensky (10) has pointed out, the dense bone around the infected mastoid does not invite infection as readily as diploic bone. The type and manner of spread are usually the same as those found in sinus disease.

Osteomyelitis Due to Metastatic Infection—When one considers the extreme vascularity of the diploe, it is rather remarkable that patients with transient periods of blood stream infection do not develop osteomyelitis of the skull more frequently. Fortunately, the tissues of the calvarium must be devitalized before bacteria circulating in the blood can start an infectious process. Injuries to the head sometimes result in osteomyelitis of the skull even though the scalp is not penetrated by the trauma. Possibly bacteria, normally circulating in the blood stream, are responsible for such infections. Sometimes an infected tooth (Blair, 11, and Hastings, 12), or a carbuncle (Kuster, 13), has been the primary site in patients developing metastatic osteomyelitis without injury to the head. However, there will always remain the unexplained case in which no etiologic factors can be found, as in the patient reported by Meyers (14).

Osteomyelitis due to hematogenous metastasis from osteomyelitis in some other portion of the body, as in the long bones, is much less common than any mode of exten-



Fig. 1 Osteogenesis in osteomyelitis of the skull. Note the numerous islands of new bone formation in the area previously excised for an extensive osteomyelitis secondary to frontal sinus disease.

sion already discussed. It does occur, however, and it must always be considered when a patient with osteomyelitis elsewhere develops evidence of a localized inflammatory process in the scalp.

Osteomyelitis Due to Trauma. Under this heading must be considered those cases developing as the result of surgical procedures and head injuries. The thickness of the scalp and the density of the outer table of the skull apparently prevent ingress of infection, as Adelstein and Courville (15) have indicated. This may account for the apparent inherent resistive powers of the skull to infection, since osteomyelitis due to trauma is much more frequent in the long bones. Traumatic osteomyelitis of the skull is usually the result of a penetrating wound with bone damage, or an abrasion of the skull with multiple minute particles of dirt ground into the bone. In some instances, osteomyelitis has followed injury without damage to the scalp. In such cases the infection has been thought to have occurred from the blood stream or from a pre-existing infection in the hair follicles. As a rule, traumatic osteomyelitis occurs in the temporal and parietal bones, whereas osteomyelitis due to sinus disease almost invariably involves the frontal bone. Osteomyelitis following neurosurgical procedures is uncommon. In these cases the disease is usually the result of faulty local

asepsis and less commonly to infection from the blood stream.

Age and Sex.—Most observers are of the opinion that osteomyelitis of the skull occurs more frequently in women than in men. This is probably due to the increased vascularity of the skull in females as compared to males, first demonstrated by Berchert. There has been noted also a predilection for the disease to occur in young patients between the ages of fifteen and thirty. Bulson (16) and others have attributed this age preference to the increased vascularity necessary for normal growth of the young skull. Our experience substantiates these views, since most of our cases have occurred in females and in the age limits indicated.

PATHOLOGY

Munro (2) defined osteomyelitis of the head as "a rarefying destructive osteitis, involving the diploic channels of the calvarium, resulting from a spread of an infective thrombotic process."

By far the most common infective organism in osteomyelitis of the skull is the staphylococcus. It is much more commonly found than the hemolytic streptococcus, although, according to Dabney (17), this latter organism is being encountered more frequently since the influenza epidemic in 1918. In the opinion of some, osteomyelitis due to the streptococcus is almost invariably fatal, whereas Woodward (18) has stated that staphylococcal calvarial infections have a much more favorable prognosis. Pneumococci have been isolated from some lesions, and in one patient, reported by Munro (2), actinomycosis was identified.

In 1913, McKenzie (3) described the pathogenesis of osteomyelitis of the skull, and was one of the first to express the opinion that it is frequently associated with frontal sinus disease. He believed that the infection extended directly through the bony wall of the sinus into the calvarium in the vast majority of cases, while in some instances the infection involved the small efferent veins of the membrane lining the

sinus and was thus carried directly into the surrounding bone. While it is true that great differences exist in the thickness of the bone and in the development of the diploe surrounding the frontal sinuses, as recently described and emphasized by Furstenburg, nevertheless, along with McKenzie, we are not impressed by its importance in the development of osteomyelitis of the skull. We believe that in most instances the development of osteomyelitis depends upon the relationship which exists between the virulence of the infecting organism and the inherent protective mechanisms of the host.

Inadequate drainage in sinus disease may play an important part in the development of osteomyelitis. It may be that "the long continued contact of infection in an undrained cavity," spoken of by Dabney (17), or the "occlusion of pus under pressure with interference of blood supply," referred to by Woodward (18), are vital factors in its development. Least important of these etiologic possibilities seems to be its dependency upon the anomalous development of the frontal sinuses, as indicated by Luc (19).

Whatever its mode of onset, the infection spreads by retrograde thrombosis in the diploe of the calvarium, after having entered the small efferent vessels in the mucous membrane lining the sinus. Once having entered the diploe, it may spread without difficulty to all parts of the calvarium because of the free anastomosis and multiplicity of its blood channels. During the first few days the bone seems practically normal except for some hyperemia of the area. The hyperemic stage soon becomes associated with small milium droplets of pus, which, within a week to ten days, increase to such an extent that the involved portion of bone becomes bathed in copious quantities of pus. The infection then spreads in a serpentine manner in all directions. The purulent material may burrow through the outer table of the skull and produce a localized abscess in the scalp. The infection may penetrate into the cranial cavity and result in any one of numerous



Fig 2 Acute localized osteomyelitis of the right frontal sinus. Note the ragged rarefied and indistinct outline as compared to the appearance of the left sinus.

intracranial complications. Fortunately, the spread is almost invariably toward the vertex, since involvement of the base of the skull is usually fatal.

There has been some discussion as to whether the inner or outer table of the vault is first involved in osteomyelitis. According to Furstenburg, a cushion of exudate develops upon the dura very early in the disease which separates it from the inner table of the skull. Since it is believed that the cranial bones receive most of their blood supply from the dura, such a collection interferes with the nutrition to the overlying bone, thus resulting in a destruction of the inner table and favoring a spread of the infection by retrograde thrombosis. Wilensky (20), however, feels that the outer table gives way first, whereas Bulson (16) believes that the pus develops on both sides of the infected bone at the same time.

It has been stated that the sutures show a tendency to limit the spread of osteomyelitis of the skull in young persons for a short period of time. This retardation is probably due to the fact that the sutures in the young are not yet united and thus



Fig 3 A spreading osteomyelitis of the squamous portion of the temporal bone following a chronic mastoiditis. Note the sun-like rarefaction spreading in all directions for a considerable distance beyond the primary focus.

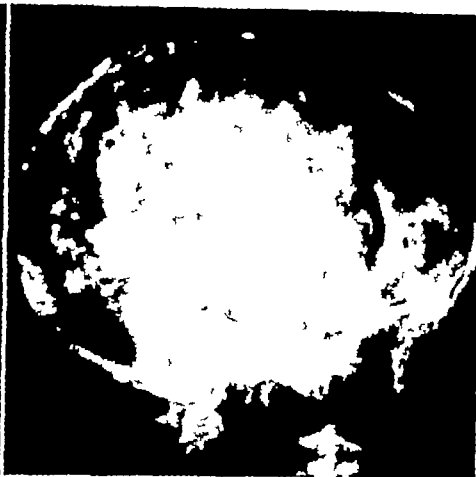


Fig 4 Same case as in Figure 3, six months later. Almost complete involvement of the entire calvarium. Numerous operations had been performed in an attempt to check the spread of the disease.

there is a break in the direct continuity of the diploe. The connective tissue and compact bone which constitute the sutures in the young skull act as a temporary barrier to the spread of infection. In adults, this zone of differentiation from the surrounding diploe is no longer present, thereby favoring the spread of the infection by direct continuity of skull structures.

Osteomyelitis of otitic origin may spread into the calvarium, involving first the squamous portion of the temporal bone (Fig 3), the occipital, parietal and frontal bones being involved later. The disease may extend from the mastoid along the petrous pyramid with resulting infection of this structure. The nature of the pathology in osteomyelitis of the petrous pyramid or so-called petrositis, a term first used by Profant (21), is dependent upon whether or not the petrosa is fully pneumatized. In the absence of complete pneumatization, the infection constitutes a true osteomyelitis, as occurs in diploic bone in any other portion of the skull. This has been fully described by Eagleton (22), who states that infection may reach the petrous apex by way of (a) a retrograde thrombophlebitis of the perilabyrinthine veins, (b) through the labyrinth, or (c) by way of the

pneumatic cells which surround the labyrinth. With pneumatization of the petrosa, the infection spreads along the mucous membrane lining the cell walls, and is accompanied by a secondary osteomyelitis of the bone trabeculations exactly as occurs in an ordinary mastoiditis. However, because of the thinness of the osseous structures in the petrous apex, the infection readily spreads to the adjacent meninges, frequently giving rise to a fatal meningitis. This is the condition to which attention has recently been called by Taylor (23), Kopetsky (24 and 25), Gevman and Clark (26), and others.

Traumatic osteomyelitis of the skull has been thoroughly described by Adelstein and Courville (15), and we shall take the liberty of quoting freely from their excellent article. According to these authors, traumatic osteomyelitis may occur as one of three varieties. The first is characterized by a purely local skull defect which is surrounded by sclerotic bone. This sclerosis has been interpreted as the result of the inherent protective mechanism of the cranial bones to an avirulent type of infection. The second variety is also a localized type of bone lesion which, however, lacks the osteosclerosis just described.

It has been attributed to the type of trauma in which multiple small particles of infected material are ground into the outer layer of the skull. Numerous small purulent foci form about each particle of dirt. These foci soon enlarge and coalesce to form one large single defect. The disease usually remains localized in the outer table of the calvarium but in some instances penetration into the diploe occurs. The third, or spreading type of osteomyelitis, resembles that seen in association with sinus disease. Its manner of spread and clinical manifestations make it indistinguishable from the picture usually seen in sinus or mastoid extensions.

The fate of osteomyelitis in a bone fragment, due to a compound fracture or in those rare instances in which osteomyelitis develops in a bone fragment the result of hematogenous metastasis, as reported by Flemming (27), merits separate discussion. It is very interesting to note that there is usually no spread of the infection beyond the confines of the fracture, if healing of the fracture has started prior to the onset of the osteomyelitis. This limitation is probably due to the fact that the granulation tissue found along the healing margins of a fracture sets up a barrier to the spread of the infection in much the same manner as was discussed with reference to the protective value of the suture lines in young skulls. If, however, infection takes place before the reparative processes have had a chance to develop, the spreading type of osteomyelitis may readily follow the injury. Osteomyelitis, resulting from neurosurgical operations upon the head may disseminate in much the same fashion as described under spreading osteomyelitis. Fortunately, the disease is usually limited by the borders of the craniotomy, if the disease involves the bone flap only.

Metastatic osteomyelitis from foci of infection elsewhere in the body is rare. The nature of its calvarial spread is somewhat different dependent upon whether the infective embolus lodges in the arterial or the venous system. In the former, the infection remains localized whereas the venous

involvement more frequently produces thrombophlebitis and retrograde extension with a more diffuse type of osteomyelitis. One must not forget that metastasis from osteomyelitis of the skull to other parts of the body may occur, as reported by Lever (28). His patient with calvarial osteomyelitis developed an infection in the os calcis during the course of his illness.

CLINICAL MANIFESTATIONS

The marked toxicity, pain, and fever usually found in acute osteomyelitis of the long bones of the body are not as prominent in osteomyelitis of the skull. Indeed, in some instances the calvarium may be entirely destroyed with few systemic signs to indicate the severity of the disease. Most patients have marked malaise, frequently associated with either a localized or diffuse headache. Fever may or may not be present, though there are some patients in whom the disease is ushered in by a severe chill, rigor, and a high temperature. Blood culture taken during the height of the symptoms may or may not be positive. When a positive blood culture is obtained, the usual clinical manifestations of septicemia prevail. In the more severe infections, euphoria and complete loss of consciousness have also been described. One of the most common associated findings in this disease is a marked hypochromic anemia, which must be adequately combated if a favorable outcome is to be expected.

When the suppurative process extends into the cranial cavity, any one of several complications may arise. An extra-dural abscess may form, with resulting evidences of increased intracranial pressure. In some patients, purulent meningitis or thrombosis of one or more of the large venous sinuses may develop. Sudden death may result from any of these complications.

With perforation of the suppurative process through the outer layer of the skull, an entirely different group of signs and symptoms develop. Perforation through the anterior wall of the frontal sinus may result in narrowing of the palpebral fissure



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the bones of the vault. In many instances the inner and outer tables consisting of dense cortical bone, appear to be in contact with each other with a minimum amount of diploe interposed. In other individuals, there is a thick layer of diploe, which in the lateral view appears as a coarse stippling of the bone. There is no definite relationship between the presence of this stippling and the thickness of the diploe, since a very thick inner and outer table and a fine diploic mesh may completely obliterate the stippling produced by the diploe even though the bones may be of unusual thickness. Considerable variation may also be found in the diploic channels or veins of Berchet, as depicted roentgenologically. There may be a complete absence of such channels or they may be numerous and of variable size and position. They appear most commonly as a stellate figure in the region of the parietal eminence. Since these channels are not always visible, the roentgenogram does not give a true picture of the vascularity of the bones of the vault. This is further indicated by the infrequency of vascular channels in the roentgenograms of children, when as a matter of fact there is a greater vascularity as compared to adults. Of considerable practical importance are the small areas of translucency frequently observed in various portions of the skull, especially along the course of the diploic channels. These are due to normal vascular dilatations and are frequently referred to as venous lakes. They deserve special consideration since they may simulate a variety of pathologic lesions encountered in the skull including osteomyelitis. One cannot account for the occurrence of osteomyelitis on the basis of the bone structure as revealed by the roentgen ray, which leads one to accept the conclusion that the important factors in the development of this condition are the virulence of the infecting organism and the resistance of the host.

Osteomyelitis of the skull is regarded pathologically as a process similar to osteomyelitis in other bones of the skeleton. The same anatomic structures exist in the

skull as are found in the long bones, the inner and outer tables corresponding to the cortex, while the diploe constitutes the marrow of the calvarial bones. The diploic veins are analogous to the venous channels, which permeate the marrow cavity elsewhere in the osseous system. Despite this similarity there are certain differences which exist, and these are reflected roentgenologically in the dissimilarity of osteomyelitis of the skull as compared to the same condition found in other parts of the skeleton.

As observed roentgenologically, osteomyelitis of the skull may be considered under two distinct headings, (1) the localized and (2) the spreading type of infection. These present distinctly different appearances. The differentiation is of the utmost importance from a clinical point of view, since the localized form does not usually endanger life whereas the spreading type carries with it a high mortality.

LOCALIZED OSTEOMYELITIS OF THE SKULL

The roentgen manifestations of the localized form can be considered best upon the basis of its etiology. Since osteomyelitis is most commonly found in association with paranasal sinus disease, this should receive first consideration. Roentgenologists are not prone to think of this condition in the routine interpretation of roentgenograms of the paranasal sinuses. Careful attention should be given to this possible complication since its detection is of such clinical importance. The rhinologist should be forewarned of the presence of bone infection so that therapeutic measures may be taken to prevent the tragic sequelæ of a spreading osteomyelitis.

As already stated, the frontal sinuses are the ones which most frequently give rise to this condition. Evidence of bone involvement is a common observation in chronic infections of these sinuses. Pfahler (32), and others, have called attention to the increased density of the bone surrounding the chronically infected frontal sinus. This osteosclerosis is regarded as the end-result of a low grade non-virulent osteitis

due to the reactionary edema. If the extension is through the floor of the sinus, one usually can feel the lesion presenting in the roof of the orbit. The orbital tissues remain unaffected until the periosteum is broken through, after which they become edematous and swollen. Ethmoidal disease may perforate into the orbit, nasal cavity, or extend up into the crista galli and involve the cribriform plate. Sphenoidal infections sometimes burrow through the base of the skull and present in the neck as a retropharyngeal cellulitis.

Osteomyelitis of the outer table differs in its symptomatology from involvement of the inner table of the calvarium. Of course, there are many patients in whom both tables are affected, and because of this there is certain to be considerable overlapping of symptoms. As a rule, however, infections of the outer table are associated with edema and tenderness soon after the onset of the disease, and according to Wilensky this edema is much more widespread than the actual area of bone involvement. This external edema and swelling overlying an area of osteomyelitis of the skull was first described by Pott (20), and has since been known as Pott's Puffy Tumor. Osteomyelitis of the inner table is usually not associated with edema and tenderness recognized externally. The only consistent symptom has been deep seated intractable pain localized to the area of bone involvement.

In spite of all that has been written and described in an effort to recognize the disease early, the clinical diagnosis still remains uncertain and difficult in the first stages of the disease.

OSTEOGENESIS IN OSTEOMYELITIS OF THE SKULL

In most of the cases reported in the literature, regeneration of the involved bone took place in those patients recovering from the disease. Furstenburg (30) and Wilensky (20) have contributed much toward our knowledge of osteogenesis in this disease. In the stage of repair, a rapid multiplication of the connective tissue ele-

ments takes place at the site of the infection. After a short period of time some of the connective tissue cells become differentiated and assume the characteristics and function of mature osteoblasts. As a result, an interlacing network of uncalcified osteoid tissue is formed, and after calcium has permeated this tissue bone trabeculae become evident. This series of events was described by Furstenburg, who has demonstrated bone regeneration in the granulations arising from the dura and affected periosteum. Mosher and Judd (31) recently demonstrated the same process in their excellent contribution on the subject. These observations at first seem at variance with the experience of neurosurgeons, who seldom see regeneration of bone after craniectomy. There is good experimental evidence to show that unless "bone dust" or "bone flakes" are allowed to remain at the operative site bone regeneration will not take place. Infection probably also plays a part in the stimulation of the factors responsible for bone regeneration, and no doubt explains the lack of regeneration in sterile craniectomies. According to Furstenburg, regeneration starts in the center of the cranial defect and gradually spreads toward the periphery but seldom joins the bone at the edge of the defect. Sometimes this process may start in multiple small foci, which in appearance closely resemble the areas of epithelization seen in the skin after multiple pinch grafts (Fig. 1).

ROENTGENOLOGIC CONSIDERATIONS

From the foregoing considerations it is quite obvious that the anatomy of the bones of the skull is of considerable importance as regards involvement by osteomyelitis. The various parts of the calvarial bones essential to the pathogenesis of osteomyelitis are well depicted in roentgenograms of the head. The inner and outer tables, the diploe, and the vascular channels are clearly shown. Roentgenography of the skull enables one to appreciate the great variation that exists in these structures in normal individuals. There is considerable variation in the thickness of

difficult to detect both roentgenologically and clinically, and no doubt usually go unrecognized

A localized osteitis or osteomyelitis of otitic origin is as common as that occurring in frontal sinus disease. Here again the local resistance is such as to prevent the infection from gaining headway in the surrounding bone. The osteosclerosis so commonly observed in the mastoid and around the middle ear denotes the frequency of this condition. The chronic otitic discharge found in association with a diploic type of mastoid or persisting after a radical mastoidectomy is usually the result of a localized osteomyelitis, although it is not always recognized as such.

The outstanding example of a localized osteomyelitis of otitic origin is the so-called petrositis. There are recognized two distinct varieties of this condition, one in which the infection spreads from the mastoid to the petrous apex by means of a retrograde thrombophlebitis, and the other in which the infection spreads by way of pneumatic cells. Obviously the latter can occur only in a pneumatized petrous pyramid. Both may give rise to suppuration of the petrous apex, a condition which is exceedingly serious, frequently resulting in a fatal intracranial infection. Taylor (23) has advocated the base view as the best means of demonstrating a petrositis roentgenologically. This enables one to compare the infected with the uninvolved side. As emphasized by Taylor, the base view should be a part of the routine mastoid examination. This plate serves for purposes of comparison with subsequent roentgenograms, should petrositis develop or be suspected. In most instances of acute mastoiditis, there will be noted a definite increased density of the petrous pyramid on the involved side as seen in the base view. This may be due to an acute hyperemia of the bone or swelling of the overlying soft parts. This appearance is usually of little consequence. In the presence of suppuration of the petrous apex, there is a loss of bone detail and the area becomes less dense and more homogeneous in appearance

than the opposite side. While our experience with petrositis is somewhat limited, we have found the anteroposterior projection of the mastoid most helpful and use it routinely in addition to the base view. In several instances, a break in continuity of the petrous ridge near the base of the petrous pyramid, as seen in the anteroposterior projection, has enabled us to detect a petrositis which has subsequently been confirmed at autopsy. In these cases, the petrous pyramids were not pneumatized, which probably accounts for the fact that the osteomyelitis spread toward the petrous ridge rather than toward the apex.

The metastatic or hematogenous osteomyelitis of the skull may be of either the localized or spreading variety. The clinical symptoms will usually direct attention to the area of the skull involved. An acute inflammatory process of the scalp, when associated with an osteomyelitis in some other portion of the body, greatly lessens the diagnostic difficulties. Occasionally such a lesion occurs from some less obvious focus of infection such as an abscessed tooth or infected tonsils. Nevertheless, the local signs and symptoms of osteomyelitis of the skull are usually such as to make this condition a distinct possibility in the differential diagnosis. Of particular interest is the spontaneous area of osteomyelitis occurring secondary to and at some distance from a focus of infection elsewhere in the head, usually a frontal sinus. Unless the primary infection is a particularly severe one, the relationship to the metastatic lesion may not be suspected. In such cases, the new area of involvement is usually the result of a thrombophlebitis of the diploic channels leading from the affected sinus, and in reality constitutes a spreading rather than a localized form of osteomyelitis. Such infections are likely to be particularly severe.

As occurs elsewhere in the skeleton, the roentgen manifestations of osteomyelitis of the skull are late in making their appearance. Usually the characteristic changes are not apparent from a week to ten days following the onset of the bone infection.

the resistance of the host having been sufficient to prevent the lesion from spreading. The thinness of the cortex in this region and the intimate contact with the underlying diploe raises the question as to whether or not such an osteitis is not in reality an osteomyelitis. Clinically and roentgenologically, the distinction cannot be made. The point, therefore, is of academic interest only. Of practical significance is the fact that the obvious and more serious form of osteomyelitis has its inception in just such a process. The acute stage of this localized osteitis or osteomyelitis is seldom recognized since the roentgen manifestations are not marked. Accompanying in acute frontal sinusitis, there may be noted at times a slight demineralization of the bone immediately surrounding the sinus. This may be the result of a disturbance in blood supply due to thrombosis of the vessels which penetrate the bone from the infected sinus, or may indicate the onset of an acute osteomyelitis. The differentiation roentgenologically is difficult to make. The clinical manifestations are of little aid since in this early stage one cannot separate the symptoms due to the sinusitis from those due to bone infection. The osseous changes may comprise the entire or only a small portion of the periphery of the sinus. Such a localized osteomyelitis is of rather frequent occurrence. The fact that in the vast majority of instances the condition subsides without serious consequences speaks well for the inherent resistance to infection of the bones of the calvarium. Unfortunately, one must wait until a somewhat greater area of involvement is seen upon the roentgenogram to be certain of an existing osteomyelitis. At this time, there are also usually some external manifestations of the condition. Upon the roentgenogram, the periphery of the sinus becomes ragged, and the rarefaction extends for a variable distance into the surrounding bone (Fig 2). When the disease is unilateral, as occurs in the vast majority of instances, a comparison of the affected with the uninvolved sinus tends to accentuate

the changes due to the osteomyelitis and renders recognition of the condition less difficult. Under favorable circumstances, the disease will remain localized and after a time will subside, the reparative process being indicated by an increased density of the bone, the extent depending upon the area of involvement.

The reactive bone changes in osteomyelitis of the frontal sinus may become quite marked. Skillern (33) has recently directed our attention to a complete obliteration of the frontal sinus by new bone formation under such conditions. In these patients, the frontal sinus upon the roentgenogram may be extremely faint or its outline may be entirely lacking, depending upon the degree of obliteration. Such cases are frequently reported by the roentgenologist as showing a lack of development of one of the frontal sinuses. Obliterative osteogenesis must be thought of when confronted by an apparent absence of one of the frontal sinuses in an adult. When the roentgenogram shows a large unilateral frontal cell which ends abruptly in the mid-line, one must suspect an obliterative osteitis in the opposite sinus. The condition is apparently not uncommon, as we have observed it a number of times during the past year. A detailed history from the patient may or may not reveal evidence of previous frontal sinus disease. In the lateral roentgenogram, one may at times detect a slit-like remnant of the original frontal sinus, or exposures made at angles somewhat different from the routine technique, or made with the Potter-Bucky diaphragm may serve to visualize the faint outline of the sinus. We have found the Waters position, as used for the maxillary sinuses, particularly valuable for this purpose.

The position of the frontal sinuses lends itself to the ready recognition of an osteomyelitis of the surrounding bone. That similar infections occur in association with the ethmoid, sphenoid, and maxillary sinuses is evident from the reported cases of spreading osteomyelitis from these sinuses. The local manifestations, however, are

difficult to detect both roentgenologically and clinically, and no doubt usually go unrecognized

A localized osteitis or osteomyelitis of otitic origin is as common as that occurring in frontal sinus disease. Here again the local resistance is such as to prevent the infection from gaining headway in the surrounding bone. The osteosclerosis so commonly observed in the mastoid and around the middle ear denotes the frequency of this condition. The chronic otitic discharge found in association with a diploic type of mastoid or persisting after a radical mastoidectomy is usually the result of a localized osteomyelitis, although it is not always recognized as such.

The outstanding example of a localized osteomyelitis of otitic origin is the so-called petrositis. There are recognized two distinct varieties of this condition, one in which the infection spreads from the mastoid to the petrous apex by means of a retrograde thrombophlebitis, and the other in which the infection spreads by way of pneumatic cells. Obviously the latter can occur only in a pneumatized petrous pyramid. Both may give rise to suppuration of the petrous apex, a condition which is exceedingly serious, frequently resulting in a fatal intracranial infection. Taylor (23) has advocated the base view as the best means of demonstrating a petrositis roentgenologically. This enables one to compare the infected with the uninvolved side. As emphasized by Taylor, the base view should be a part of the routine mastoid examination. This plate serves for purposes of comparison with subsequent roentgenograms, should petrositis develop or be suspected. In most instances of acute mastoiditis, there will be noted a definite increased density of the petrous pyramid on the involved side as seen in the base view. This may be due to an acute hyperemia of the bone or swelling of the overlying soft parts. This appearance is usually of little consequence. In the presence of suppuration of the petrous apex, there is a loss of bone detail and the area becomes less dense and more homogeneous in appearance

than the opposite side. While our experience with petrositis is somewhat limited, we have found the anteroposterior projection of the mastoid most helpful and use it routinely in addition to the base view. In several instances, a break in continuity of the petrous ridge near the base of the petrous pyramid, as seen in the anteroposterior projection, has enabled us to detect a petrositis which has subsequently been confirmed at autopsy. In these cases, the petrous pyramids were not pneumatized, which probably accounts for the fact that the osteomyelitis spread toward the petrous ridge rather than toward the apex.

The metastatic or hematogenous osteomyelitis of the skull may be of either the localized or spreading variety. The clinical symptoms will usually direct attention to the area of the skull involved. An acute inflammatory process of the scalp, when associated with an osteomyelitis in some other portion of the body, greatly lessens the diagnostic difficulties. Occasionally such a lesion occurs from some less obvious focus of infection such as an abscessed tooth or infected tonsils. Nevertheless, the local signs and symptoms of osteomyelitis of the skull are usually such as to make this condition a distinct possibility in the differential diagnosis. Of particular interest is the spontaneous area of osteomyelitis occurring secondary to and at some distance from a focus of infection elsewhere in the head, usually a frontal sinus. Unless the primary infection is a particularly severe one, the relationship to the metastatic lesion may not be suspected. In such cases, the new area of involvement is usually the result of a thrombophlebitis of the diploic channels leading from the affected sinus, and in reality constitutes a spreading rather than a localized form of osteomyelitis. Such infections are likely to be particularly severe.

As occurs elsewhere in the skeleton, the roentgen manifestations of osteomyelitis of the skull are late in making their appearance. Usually the characteristic changes are not apparent from a week to ten days following the onset of the bone infection.

A negative roentgenogram within this time does not therefore exclude an osteomyelitis. The condition may start as a small area of rarefaction which may be difficult or impossible to distinguish from a venous lake. A knowledge of the history and of the location of the external manifestations is essential if one is not to overlook or fail to appreciate the significance of such a small radiolucent area. At other times the earliest evidence may be a small area of slight demineralization which blends imperceptibly with the surrounding bone. The radiologist must have osteomyelitis in mind if he is to detect and recognize such a slight alteration in bone density. But it is at this stage that recognition is of most importance since the diagnosis from the clinical point of view is usually not definite. Later, when the small rarefaction has increased considerably in size or the slightly demineralized area has assumed a moth-eaten appearance (Fig. 3), the diagnosis is usually no longer in doubt and the roentgen examination serves merely to graphically record the severity and extent of the lesion. In the purely localized form of metastatic osteomyelitis, the infection shows little tendency to spread beyond the confines of the primary involvement. Complete absorption of bone may or may not occur. Usually, various sized, irregular, and dense sequestræ stud the affected area which merges gradually with the surrounding normal bone.

Healing occurs by bone regeneration which fills in the defects resulting from osseous destruction. The area takes on an increased density which is quite irregular in appearance. If the infected bone has been removed surgically a permanent cranial defect will remain unless the area of involvement is very small or unless bone chips are left in the area to initiate osteoblastic activity. The edges of such defects are usually smooth and rounded, presenting the appearance of normal bone. Increased density of the edge of the cranial defect does not occur unless such edges have been the site of an osteomyelitis.

Under traumatic osteomyelitis must be considered those infections occurring inci-

dent to injuries of the head and those following various surgical procedures upon the calvarium. These are not common causes of osteomyelitis of the skull, since injuries severe enough to damage the skull usually receive prompt surgical treatment in which prophylactic measures against infection are used and because cranial surgery is performed under aseptic conditions. Nevertheless, osseous infections do occasionally occur and these are usually of the localized variety. Spreading osteomyelitis seldom results from a fracture of the skull, for the same reason that bone infection complicating fractures of the long bones usually remains localized. The fracture serves to decompress the bone, and the infection, taking the path of least resistance, escapes to the soft tissues.

In traumatic osteomyelitis the bone changes present the same appearance roentgenologically as has been previously described. The edges of the fracture or craniotomy wound become slightly rarefied, irregular and less distinct. At this stage, it may be difficult or impossible to differentiate the appearance of an early osteomyelitis from the localized demineralization of bone which normally occurs under such conditions. Careful correlation with the patient's clinical manifestations is essential for proper interpretation. As the infection progresses, small pin point foci of rarefaction extend for a variable distance into the surrounding bone. Opportunity for the wound discharges to escape will usually prevent the infection from spreading. With subsidence of the infection, the areas of involvement increase in density and may stand out in sharp contrast to the neighboring bone. Very little if any osseous regeneration occurs beyond the edges of a craniectomy opening. Fracture lines and osteoplastic flaps ossify, as normally occurs in the absence of infection.

SPREADING OSTEOMYELITIS OF THE SKULL

The spreading type of osteomyelitis is the same pathologically and roentgenologically, regardless of whether the infection proceeds from a focus in the paranasal si-



Fig 5 Same case as in Figure 4 six months later. The infection has practically subsided. There is now extensive new bone formation throughout the skull producing a marked irregularity in contour and an increase in density. (This case is to be reported by Dr O C Hirst.)



Fig 6 Spreading osteomyelitis along the diploic channels. Extensive osteomyelitis of the frontal bone following acute frontal sinus disease. Numerous small areas of rarefaction are clearly shown along the diploic channels extending as far back as the occipital bone. Complete recovery under conservative treatment.

nuses or mastoid, or whether it is metastatic or traumatic in origin. It does, however, present a distinctly different picture from that seen in the localized form. Dissemination may occur in one of two ways, either by continuity or by way of the diploic channels. When the infection spreads by continuity, the involved area will be found studded by minute foci of rarefaction, the appearance being quite characteristic. The rate of progression of this type of infection is not very rapid. Again it must be remembered that the infection has advanced for some distance beyond the visible point of involvement as detected upon the roentgenogram. As the condition progresses, the small points of rarefaction enlarge and coalesce, giving the involved area a characteristic moth-eaten appearance. The area, deprived of its blood supply, becomes studded with small irregular and rather dense sequestra. Always in advance of the spreading lesion is to be found the sieve-like zone of rarefaction (Fig 3). Such a lesion will usually continue to spread until surgical drainage is established. This is not always successful in checking the condition, and the lesion may continue to

spread until the entire calvarium is involved (Fig 4), or death ensues as a result of toxemia, meningeal or cerebral complications. In cases in which the infection is successfully combated, the zonal area of irregular rarefaction disappears, bone regeneration takes place between the sequestra, and eventually the osseous continuity is restored. However, there remains an irregularity both in contour and density to mark the site of the infection (Fig 5).

In the second type of spread, there is also a characteristic appearance upon the roentgenogram. The progression in this instance is along the diploic channels or the veins of Berchet, and the dissemination occurs more rapidly than in the spread by continuity. Early in such a case, there will be noted small areas of rarefaction along the course of the diploic channels. They have somewhat the appearance of venous lakes but are usually smaller in size and follow the vascular pathways more closely. Furthermore, comparison with previous roentgenograms when available show them to be of recent origin. The bone between the venous channels appears to be entirely normal. One may not recog-

nize this appearance as a manifestation of a spreading osteomyelitis unless the condition is fairly marked. However, in subsequent examinations when the infectious foci have become larger, the nature of the condition is readily recognized (Fig. 6). These small areas of involvement may subsequently serve as foci from which larger areas may become affected, although the infection may remain fairly well localized along the veins of Berchet. As has been previously recorded, osteomyelitis tends to spread upward toward the vertex. This is well illustrated in those infections spreading along the diploic channels (Fig. 6). When the condition responds favorably to therapy, the areas of rarefaction along the venous channels gradually disappear and eventually the bone returns to normal leaving no trace of the previous infection. When the affected areas are fairly large bone regeneration occurs, producing the same irregularity in contour and density as previously described.

Occasionally an isolated area of osteomyelitis makes its appearance quite remote from the primary focus without apparent involvement of the intervening bone. The infection in such instances usually spreads by way of the venous channels, the secondary focus resulting from an infected thrombophlebitis. The roentgen characteristics of the secondary lesion are the same as those already described.

In the well established case of spreading osteomyelitis it is extremely difficult from the roentgenogram to know precisely the pathologic changes which are taking place. When the involved area becomes extensively moth-eaten in appearance, one cannot be certain whether the irregularly shaped particles of bone represent sequestra or viable portions of osseous tissue

be extruded or. Likewise, when, it cannot from the roentgen areas of rarefaction represent of infection from the clinical serial roentgen.

It must be of the skull leaves much to the roentgen until one week infectious invasion the detection when a precise desired. This to gain such he to overcome mind that the is an inch or more the roentgenog taken cognizance to completely.

The difficulty in true and remain ready referred to value of the r the successful in teomyelitis of th the clinical man the roentgen ex valuable adjunct junction with th distinct aid to t many difficult p: serious condition

It is not our p: ment of osteomy roentgenologic c with the serious the difficulties to

ence is not sufficient to permit of its evaluation as a therapeutic agent in this disease. It was employed in one of the severest cases of osteomyelitis of the skull that we have ever encountered. This patient is making a remarkable recovery, whether because or in spite of roentgen therapy cannot be stated. The modern trend today is toward the treatment of all varieties of inflammatory lesions by roentgen irradiation, and it is entirely possible that this form of therapy may have much to offer in osteomyelitis whether it involves the skull or other portions of the skeleton.

SUMMARY

(1) It has seemed desirable to record and emphasize the roentgen manifestations of osteomyelitis of the skull, since this phase of the subject has received but scant attention.

(2) A résumé is given of the modern concepts of the etiology, pathology, and clinical aspects of the condition, since a knowledge of these is essential to a full appreciation of the roentgenologic manifestations.

(3) Roentgenologically, there is recognized two distinct forms of the disease, a localized and a spreading variety.

(4) The roentgen appearance of these varieties are described on the basis of their etiology. The condition may be secondary to paranasal sinusitis or mastoid disease, or may be metastatic or traumatic in origin.

(5) The limitations of the roentgen examination are discussed.

(6) Roentgen therapy is suggested as an adjunct to the modern method of treatment of osteomyelitis of the skull.

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ARTHROKATADYSIS OF THE HIP JOINT¹

(REPORT OF FIVE CASES)

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THIS imposing name meaning "subsidence or sinking-in of a joint," was suggested by P. J. Verrall (1), of London in 1929, for a peculiar condition of the pelvis which was first described by Otto, in 1824. The characteristic feature is an intrapelvic protrusion of the acetabulum and the head of the femur.

One of the earliest articles in this country was written by Philip Lewin (2), in 1924, who reported a case under the title of "Osteo-arthritis Protrusion of the Acetabulum." Prior to this, 38 cases had been reported. Pomeranz (3), in 1932, using the name "Intrapelvic Protrusion of the Acetabulum (Otto Pelvis)," gives an extensive review of the literature, stating that 79 cases had been previously reported and adding six of his own. Cary and Barnard (4) report two cases, stating that they prefer the name "arthrokatadysis," as it more accurately describes the condition. An additional case is reported by Reed (5) in July, 1933. Walter Mercer (6) in his textbook, "Orthopedic Surgery," describes a case by the same title in his chapter on chronic arthritis. Schaap (7), Golding (8), and Gellman (9) each report a series of cases during 1934.

The condition is characterized by a protrusion of the acetabulum into the pelvis and a narrowing of the joint space. This is apparently the end-result of a localized de-

structive process in the hip joint affecting essentially the acetabulum, resulting in softening and thinning of its wall. The deformity is evidently the result of weight-bearing and muscle pressure, the femoral head, pressing against the weakened acetabular floor, literally bores its way into the pelvis. The great trochanter approaches, and finally may impinge against the ilium, while the lesser trochanter comes closer toward the ischium. The hip joint is thus markedly deepened, its motion restricted, and the extremity shortened.

This yielding of the acetabulum may perhaps be considered analogous to the condition sometimes seen in chronic arthritis of the knee joint, in which the inner tibial condyle becomes depressed by the pressure of the overlying inner femoral condyle.

This is not a specific disease. The etiology factors in the cases reported in the literature have been quite variable, including osteo-arthritis, gout, gonorrhea, syphilis, tuberculosis, trauma, and endocrine disturbances. In a personal communication, Mercer tells us that he believes the case he described was due to toxins of the tubercle bacillus, *i.e.*, Poncelet's disease. Pomeranz suggests that it may be an "atypical but essentially non-specific arthritis of the hip joint."

Schaap believes that some of these cases may be ascribed to a congenital anomaly in which the acetabular cavity is too deep.

The condition has been seen most often

¹Preliminary Report read before the Chicago Orthopedic Society, March 12, 1934.

in middle-aged females, and, in the majority of the reported cases, unilateral. The symptoms are those of a progressive chronic

regular with the aid of mineral oil. Several teeth were missing but the remaining ones were negative clinically and roentgenologi-



Fig 1 Case 1 D S aged 55 years showing bilateral arthrokata-dysis. The acetabula are definitely thinned while the spherical shape of the femoral heads is preserved. Some hypertrophic change is seen in the head of the right femur.

arthritis, and the roentgenograms are characteristic, revealing a deepening of the acetabulum, with thinning of the medial and inferior wall, considerable eburnation, and narrowing of the joint space due to absorption of cartilage.

Conservative treatment with diathermy, radiant heat, massage, traction, and salicylates may give symptomatic relief, and occasionally plaster spica casts or braces may be used. If pain and disability persist despite these measures, arthroplasty or arthrodesis may be performed in properly selected cases.

CASE REPORTS

Case 1 Mrs D S, a housewife, aged 55, widowed, was seen on July 29, 1933, complaining of generalized joint pains and stiffness of two years' duration, involving especially the hips and knees. The symptoms were worse in the morning and were aggravated before rain. The bowels were

regular. The tonsils had been removed one and one-half years previously without influencing the joint symptoms. There was no story of sinus infection or gall-bladder disease. The patient had not lost any weight. She had gone through the menopause at the age of forty-eight.

She had had mineral baths, mud baths, colonic irrigations, diathermy, massage, fever treatment, and twelve injections of vaccine without relief.

The patient was able to walk but a few short steps and that with considerable difficulty. It was also very difficult for her to roll over when placed on the examining table. The essential findings were a marked limitation of motion in both hips, being worse on the right side. Flexion and extension were present to a slight degree, but rotation and abduction could not be performed. There were bilateral contractures of the knees (at 170°) with effusion. The hands were typically arthritic. The

general physical examination was otherwise essentially negative except for a mod-

The Kahn test was negative. Roentgenograms of the hips (Fig. 1) showed definite



Fig. 2. Case 2. M. W. aged 71 years. arthrokataclasis of the left hip. The intrapelvic protrusion of the head of the femur is seen distinctly (a) with the greater trochanter approaching the ilium. (b) Shenton's line is definitely broken and (c) the lesser trochanter is above the level of the ischium.



Fig. 3. Case 3. B. R. aged 59 years. bilateral arthrokataclasis, more marked on the left side. Note the peculiar hypertrophic changes of the left acetabulum and femoral head.

erate degree of pyorrhea. Urinalysis, blood count, and blood chemistry were normal.

bilateral arthrokataclasis. The roentgen report reads "Bilateral intrapelvic acetab-



Fig 4

Fig 4 Case 4 C M aged 45 years arthrokata-dysis as the end result of Neisserian arthritis

Fig 5

Fig 5 Case 5 The characteristic bulging of the acetabulum is seen the patient was 38 years of age In this case however there is marked sclerosis and thickening of the acetabular floor as compared with the preceding cases There is also some hypertrophic change involving the ischial spine which may be callus formation following an acetabular fracture

ula Bilateral arthritis with extreme narrowing of the joint spaces and condensing bone reaction Spur formation, right "

The patient was in the Michael Reese Hospital from July 26, 1933 to Aug 9, 1933, where she received massive doses of salicylates and intensive physical therapy, consisting of diathermy radiant heat, and massage The stiffness of the hips was markedly improved but some of the pain and swelling of the knees persisted On discharge from the hospital the patient's gait was definitely improved

Case 2 M W, a housewife, aged 71 was seen in Mandel Clinic Michael Reese Hospital on Aug 12, 1932 She complained of pain in the left hip and knee for

six years, becoming progressively more severe She stated that fifteen years ago she had fallen down several stone steps and injured the left hip and knee region which was discolored for two months The hip was painful for some time, but the patient was never confined to bed After this she felt well up to six years ago when she noticed a gradual onset of pain in the left hip on walking This became progressively more severe, so that for the previous two years she walked with the aid of crutches in order to relieve the painful hip from weight-bearing The pain seemed worse in rainy weather Radiant heat therapy gave temporary relief Recently she began to have pain in the left knee and in both arms from the shoulders down The patient was com-



Fig 6 Case 5. Same patient as shown in Fig 5 post-operative. Roentgenogram showing resection of marginal osteophytes from the head of the femur.

pletely edentulous. The throat was negative. The bowels were constipated.

The essential findings on examination were a 30° flexion deformity of the affected hip, with pain on attempted passive extension. There was tenderness over the great trochanter and over the left sacro-iliac joint. The Fabere sign was strongly positive, there being marked limitation of abduction and rotation. The left lower extremity was 2 cm shorter than its fellow. The knees and shoulders revealed a moderate amount of crepitus but had a good painless range of motion.

The roentgenograms (Fig 2) showed a definite picture of arthrokata-dysis of the left hip joint and an osteo-arthritis of the right. The roentgenologist's impression was that of an old central fracture of the left acetabulum.

Case 3 B R, a housewife, aged 59, applied for orthopedic treatment at Mandel Clinic on Oct 25, 1931. Her chief complaint was pain over the lateral aspect of the left thigh of ten years' duration. This was associated with stiffness of the left hip.

She also noted pain in the left knee and right thigh, worse on change of weather. Two years previously an attack of arthritis involving the left hip had been relieved by physical therapy.

The teeth were all absent. The tonsils were atrophic. The patient had chronic constipation with a story suggesting cholecystitis. She had had an essential hypertension for some time, her blood pressure at this time was 190/110.

Examination revealed an obese female, limping to protect the left hip. The lumbar lordosis was exaggerated, and there was spasm of all of the muscles about the left hip. There was a 20° flexion contracture of the hip, and a range of flexion of from 160° to 135°. Abduction was fair but no adduction or rotation was present.

Roentgenograms revealed bilateral arthrokata-dysis with extensive hypertrophic changes involving the left hip.

Treatment consisted of radiant heat, diathermy, and massage, together with the usual palliative medication and weekly injections of Crowe's polyvalent vaccine.

Little change was noted under this régime, the patient continuing with some complaints throughout 1932. In April, 1933, however, she reported her pain as much diminished and was advised to continue with physiotherapy.

Case 4 C M, a male, aged 45, developed an acute destructive arthritis of the right hip in April, 1929, about five weeks after the onset of an acute Neisserian urethritis. Treatment consisted of traction, followed by immobilization in a double plaster of Paris spica. Physical therapy was begun two months later, but the joint gradually stiffened so that only a slight degree of motion remained. In March, 1933, measurement revealed one-half inch of shortening of the right lower extremity, and roentgenograms showed definite intrapelvic protrusion. The patient had, however, very little disability and walked with a slight painless limp.

Case 5 J S, a male, aged 38, was seen at the outpatient orthopedic clinic of the Cook County Hospital in March, 1935.

About one year previously, he had injured his left hip in making a quick leap forward to avoid being struck by a truck. He had never been bedridden, but complained of persistent pain in the groin which radiated down the thigh anteriorly to the knee, becoming gradually worse.

Examination revealed a good range of anteroposterior motion in the hip joint, but pain on attempted abduction. The roentgenogram showed sclerosis and intrapelvic protrusion of the acetabulum and hypertrophic changes in the femoral head and acetabulum.

Conservative measures of physical therapy and salicylates failed to give him relief from pain. A modified arthroplasty was performed on March 24, 1935. Through a straight antero-lateral incision, a muscle-splitting exposure of the head and neck was accomplished. The excrescences of the margin of the head of the femur were chiselled off. The patient made an uneventful recovery, and was discharged walking with crutches within two weeks from the date of operation. He has been observed in the outpatient clinic five weeks from the day of operation with a normal range of painless motion.

104 South Michigan Avenue

CONCLUSIONS

1 Arthrokata-dysis, or "sinking in of a joint," describes accurately the condition known as Otto pelvis, or intrapelvic protrusion of the acetabulum.

2 It is not a disease entity, but is a structural deformity due to a localized malacia of the acetabular floor.

3 Five cases are reported.

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Fig. 6. Case 5. Same patient as shown in Fig. 5 post operative. Roentgenogram showing resection of marginal osteophytes from the head of the femur.

pletely edentulous. The throat was negative. The bowels were constipated.

The essential findings on examination were a 30° flexion deformity of the affected hip, with pain on attempted passive extension. There was tenderness over the great trochanter and over the left sacro iliac joint. The Fabere sign was strongly positive, there being marked limitation of abduction and rotation. The left lower extremity was 2 cm. shorter than its fellow. The knees and shoulders revealed a moderate amount of crepitus but had a good painless range of motion.

The roentgenograms (Fig. 2) showed a definite picture of arthrokata-dysis of the left hip joint and an osteo-arthritis of the right. The roentgenologist's impression was that of an old central fracture of the left acetabulum.

Case 3. B. R., a housewife, aged 59, applied for orthopedic treatment at Mandel Clinic on Oct. 25, 1931. Her chief complaint was pain over the lateral aspect of the left thigh of ten years' duration. This was associated with stiffness of the left hip.

She also noted pain in the left knee and right thigh, worse on change of weather. Two years previously an attack of arthritis involving the left hip had been relieved by physical therapy.

The teeth were all absent. The tonsils were atrophic. The patient had chronic constipation with a story suggesting cholecystitis. She had had an essential hypertension for some time, her blood pressure at this time was 190/110.

Examination revealed an obese female, limping to protect the left hip. The lumbar lordosis was exaggerated, and there was spasm of all of the muscles about the left hip. There was a 20° flexion contracture of the hip, and a range of flexion of from 160° to 135°. Abduction was fair but no adduction or rotation was present.

Roentgenograms revealed bilateral arthrokata-dysis with extensive hypertrophic changes involving the left hip.

Treatment consisted of radiant heat, diathermy, and massage, together with the usual palliative medication and weekly injections of Crowe's polyvalent vaccine.

Little change was noted under this régime, the patient continuing with some complaints throughout 1932. In April, 1933, however, she reported her pain as much diminished and was advised to continue with physiotherapy.

Case 4. C. M., a male, aged 45, developed an acute destructive arthritis of the right hip in April, 1929, about five weeks after the onset of an acute Neisserian urethritis. Treatment consisted of traction, followed by immobilization in a double plaster of Paris spica. Physical therapy was begun two months later, but the joint gradually stiffened so that only a slight degree of motion remained. In March, 1933, measurement revealed one-half inch of shortening of the right lower extremity, and roentgenograms showed definite intra-pelvic protrusion. The patient had, however, very little disability and walked with a slight painless limp.

Case 5. J. S., a male, aged 38, was seen at the outpatient orthopedic clinic of the Cook County Hospital in March, 1935.

ilium This lipping is also seen in four places on the right side and noticeably on both sides of the lumbar vertebræ

A There is a slight amount of lipping on the upper border of the body of the five lumbar vertebræ, and on the lower borders of the lower four lumbar vertebræ

A That lipping is a deposit of calcium, due to and the direct result of a generalized, or systemic infection in the body of the individual of whom these roentgenograms were made

A In Exhibit D, I see a lateral view of the foot of an adult human. It is a pretty good sized foot and there appears to be no decided departure from normal

A Exhibit E shows an adult human foot, the film made from above downward. This shows an abnormality of the outer sesamoid bone under the great toe

A Probably this abnormality of outline is due to the same cause as the deposits on the bodies of the vertebræ, if this film was made from the same individual

A There is an excessive calcific or bony outgrowth on the sesamoid bone, making it much broader and more angular than normal

A There is also some lipping of the edges of the external cuneiform bone, indicating that this deposit or series of deposits is a generalized condition, appearing as it does on the back bones, the pelvis, and the foot. This film also shows some deposit on the ankle or shyn bone

A This is marked "Exhibit F." Yes, it shows some of the same sort of deposit as do the other bones

Q In speaking of a generalized condition, I mean that it is a condition found in various parts of the body, as far as these films show

A Yes, probably every bone in this individual's body has some of this same kind of deposit upon or within it

Q I would say that the nature of this generalized condition in simple terms, is what is commonly called rheumatism or a rheumatic condition

A The deposit is made of a material which looks like bone. It is not true bone but it looks like bone. It has not the fine

structure of bone but is built up of thin layers of calcium. It is harder than bone, will chip and break like bone

A No, these x-ray films show no bones which have been fractured by external violence, except that in the film which shows the coccyx

A The condition of the coccyx may be due to its having been fractured

Q Can you tell, assuming that these x-ray pictures of the foot were taken just a few days ago, and the pictures of the backbone and the pelvis, Exhibits A, B, and C, were taken in May, 1923, of a woman about thirty years of age, an opera singer, opera singer for several years, and by "several years" I mean at least nine or ten years or something like that, and she was in an automobile collision with an electric street car in August, 1922, about a year and a half ago—about two and one-half years almost, down on her hands and knees on the bottom of a machine, in the back part of an automobile which had had a collision with a street car, a pretty severe collision, but the machine was not tipped over, and she was not thrown out, she remained on her hands and her knees on the floor of the car, and the automobile ran 75 or 100 or 150 feet and went into a window, stopped right side up, and she was dazed and unconscious for a little while, and they took her in another machine and went over to the hospital, and she became rational, called for her husband before she went to the hospital, and when she got in the hospital she was examined by a surgeon of the hospital, he was a graduate physician senior interne at the time, he having graduated about a year before in his profession, he went over her and made an examination of her, and found no fractures, her husband was in the hospital and she went into the same room with her husband and stayed there in that same room with her husband, with him about five days and then she left the hospital. The first day she was up, sitting in a chair, a wheel chair, one day she walked into the lavatory, toilet room of the hospital, without any assistance, and in five or six days she rode home in a machine, her bowels

SOME LAWSUITS I HAVE MET AND SOME OF THE LESSONS TO BE LEARNED FROM THEM¹

(THIRD INSTALLMENT)

By I S IROSLER, M D, F A C R, F A C P, Chicago

THEY PAID FOR AN OLD OSTEO-ARTHRITIS

THIS was an instance of a woman occupant of a rapidly speeding automobile which ran into a street car that had the right of way and was crossing a boulevard. Suit was filed against the corporation operating the street car. The writer was called by the defendant to testify as an expert witness. The trial occurred in 1925 before a jury of average intelligence.

While there may have been some question as to the liability, there was no question as regards the injury—she certainly was not injured.

After qualifying me as an expert in roentgenology, direct examination was begun by defendant's attorney. The questions are omitted, but may be inferred from the answers.

A The film marked "Plaintiff's exhibit A," which I hold in my hands, is a roentgenogram or x-ray film of a human thorax (except the upper portion) and a part of the abdomen. The lower nine dorsal vertebrae are normal, or nearly so, in outline and form, except that the lower four of them have what we call osteophytes at the angles of the bodies.

I The intervertebral discs are the soft cartilage portions of the spinal column which render it flexible. These are cushions between the bodies of the bones.

A Osteophytes are the result of more or less constant inflammation, usually in some other part of the body. They are made up of bony or calcific deposits upon the angles of these bones. In this film they are on four vertebrae. There are similar exostoses or

bony or calcific deposits on several of the ribs.

A I also note that the heart is somewhat enlarged to the right and left in that portion called the ventricles. This enlargement is probably due to the same cause, that is, a long-standing chronic disease.

A There are also some calcific deposits in the lungs. These are calcified glands, which are probably the result of early childhood disease.

A The film marked "Exhibit B" is evidently a roentgenogram of the thorax, showing a diagonal view of an adult female. In the bodies of the vertebrae in this film, the osteophytes or calcific deposits show much more clearly, because we see the anterior or front surface of the bodies of these bones. The angle is probably exaggerated in this view, and the deposits show somewhat larger than they really are. Normally the outline is slightly rounded, and these places in this film are angular and sharp. The so called angle of the bodies of the vertebrae is increased by the deposits.

I I can see this deposit on the bodies of five vertebrae in this film.

A No, there is nothing abnormal about the height of the bodies of the vertebrae.

A I mean what is ordinarily known as lipping. That is a term used by those who handle these roentgenograms and make diagnoses from them—x-ray specialists.

A Lipping, or increase in the angles of the bodies of the vertebrae, is present in five of them. It is on the upper angles of some of them and on the lower angles of all the upper four lumbar vertebrae as well as on the last or twelfth dorsal.

A Exhibit C shows the lumbar vertebrae, the coccyx, sacrum, and part of the pelvic bones, the ilia. The coccyx is apparently tilted slightly to one side. There is lipping at the junction of the sacrum and

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A My testimony is not whether anybody is to blame or not I am testifying as to what I see in these x-ray films and what my training, experience and the knowledge gained from these, show me and indicate to me I have no knowledge of any accident, except what was given me in the hypothetical question

A I do not know whether it is material to show whether these conditions existed before the accident or only after it

A Nothing was said to me about compensation for this opinion

A Compensation was not mentioned because I did not feel called upon to ask about it

A Yes, I have testified for them before I have testified for you also

A Certainly, I expect to be paid for my services, but it was not mentioned until you brought it up

A I was called here by a Mr Stewart, over the telephone last Thursday

A Yes, I talked with Dr Hubeny

A Dr Leeming and Mr Stewart were both present when I examined the films I do not remember who handed them to me

A I told Dr Hubeny what I saw in the films, and we agreed that we both saw the same things, last Thursday afternoon

Q You insist that the coccyx never heals?

A The coccyx when fractured during adult female life, never heals spontaneously

A Yes, that is why I say that the coccyx in the film shown me, if fractured at all, must have been fractured in childhood

Q If fractured at all?

A Yes, if fractured at all There are so many anomalies in the spine, and the coccyx is one of the spinal parts, that this may be one of the not at all rare anomalous variations from the normal

A No, not at all No, I do not know that it is the commonest thing in the world to fracture a coccyx and have it heal in a corrected position It is not nearly as common as is the lack of knowledge of human ailments by some attorneys I know

1 The coccyx does not heal in adults, who are up and about

A A person—man, woman, or child—cannot sit down in comfort with a fractured coccyx, a broken coccyx

A The junction of the sacrum and the coccyx is a flexible joint

Q Is it not a fact that any two bones in apposition will grow together?

A I take it that you mean any two fragments of a broken bone If that is your meaning, my answer is "No, if they are not so immobilized as to be held constantly in apposition" It is not at all unusual for fractures not properly immobilized to heal by fibrous union, forming a false joint

Q Suppose you were wearing a specially constructed thing, a great big rubber band, eight inches wide, so that you won't sit on the coccyx, then it might unite

A I can imagine that it might, yes

Q Then your argument that because it is grown together in adult life proves it never was fractured, wouldn't work, would it?

A My statement is based upon experience, study, and the knowledge of medicine and surgery and the records of same

A It is my opinion that a fractured coccyx will not unite in an adult female

A If the coccyx shown in the film under discussion has been fractured, it is my opinion that such fracture occurred in early childhood

A No, there is no shortening of the vertebræ No evidence of shortening

Re-direct Examination

A I said that there is no visible evidence of shortening of the bodies of the vertebræ in the films

A That observation is based upon the study of many hundreds of bodies of human vertebræ, and comparison with each other in the films examined

A Yes, every time the bowels act, the fragments of a broken coccyx move

A Yes, that is one of the very important causes for the failure of a fractured coccyx to heal or unite The reason they might or do unite in childhood, is because all bones heal more readily in childhood

1 Yes, I expect to be paid for coming

moved and the function of the bowels and bladder were normal and natural. Also that is the x-ray picture of her coccyx taken at the time I told you. Would you be able now to form an opinion as to whether that coccyx was fractured in that accident or not?

A I would be.

Q What is your opinion?

A My opinion is that that coccyx was not fractured in that accident.

Q Assuming that this woman before August, 1921, had not had any serious accident or illness, that is, nothing that she recognized as such, and that she kept right on with her regular work all the time. In fact, she has kept with it since, and is now engaged in it, she had no acute attack of any kind prior to August, 1921, to cause her discomfort or pain in the back or the region of the coccyx itself, not enough so that she would recognize it. Taking that all into consideration, would you be able to express an opinion, Dr. Trostler, whether this inflammatory condition or arthritis or whatever name you gave it—what is the name you gave it?

A We call it, when it occurs in the joints, arthritis, and when it occurs in the backbone we call it spondylitis. Osteoarthritis will cover the whole thing.

A Yes, I have an opinion as to whether that change in the coccyx occurred prior to August, 1921, my opinion is that it existed prior to that time, because if it had been fractured any time within her adult life, there would not be the bony union there is now. In case there had been a fracture in that coccyx during comparatively early childhood, it might have united and formed in the position shown in the film.

A Fracture of the coccyx in adult life does not heal and unite to the structures just above it, as shown in that film.

Q Now, Doctor, sometimes a person who has these germs of infection in their system, if they are in an accident, although there may be no fracture, but a severe wrenching and strain, and bruises may, if these germs are in the system, may, on account of the lowered resistance, and so

forth, may cause these to localize and commence an osteoarthritis. Is that right?

A That is right.

Q What I am trying to get at is this. Now from the history I just gave you a few minutes ago, are you able to give an opinion as to whether the accident described, owing to the presence of germs in the body, set up an arthritis since Aug. 27, 1921, or whether the arthritis itself, or the deposits or the spondylitis, whichever terms you gave to it, existed prior to Aug. 21, 1921?

A I think that that deposit existed for not less than five years.

Q Not less than five years?

A Not less than five years and probably longer than that, considerably longer than that.

Cross Examination by Plaintiff's Attorney

A This indicates a general rheumatic condition. If she came to me, I would send her to some other physician who would prescribe for her. That is outside of my line of practice. I seldom prescribe medicine, except in conjunction with x-ray treatments, or in patients from outside of this city who are staying for treatments.

A Yes, I am a physician, but I specialize in radiology and most all of my patients are referred to me by other physicians.

A Yes, I can tell from these films, without any more history of the case than that just given to me, what the minimum period would be, during which this condition of the spine must have existed. The minimum period, with the amount of deposits shown in this film, would be greater than two years.

A Yes, I have talked with Dr. Leeming. I first saw him or some one in connection with this case last Thursday noon, I saw the films at that time.

Q So that the jury has that correct. Don't you understand that if it appeared that this bone deposit existed before this accident, this company would not be to blame, and if it appeared that it existed after this accident, this company may be to blame?

others that may be of interest I call your attention to ²⁵ case, in which I was involved as an expert and helped plan the prosecution of the case for the widow I knew her husband, Dr ²⁶, very well personally and took a great deal of interest in it and, of course, derived a great deal of pleasure and satisfaction out of the final victory for Mrs ²⁷, besides receiving considerable praise from several sources as the result of my activity in the case. The insurance company fought hard and long, using all the tactics which high priced lawyers can and will use. They had me on the witness stand three times and grilled me, or rather tried to grill me, to the extreme, but I was sure of my ground, and did not contradict myself once in the hours that the lawyers propounded their questions. I did not get a nickel for my services, but the experience was worth much to me in the satisfaction of a deed well done and justice furthered.

"Another case which might be considered to apply in the one you mentioned, is *Hewig vs Business Men's Accident Assn of America* (234 S W R, 853). That is a Missouri Supreme Court decision, which holds that the insurance association was not liable when the plaintiff, a *physician*, was not immediately disabled by an accident.

'Another case, in which the court said that an occupational disease is not an accident might be applied. That is *Peru Plow and Wheel Co vs Industrial Commission et al*, an Illinois case reported in 142 N E R, 546.

'I am sorry that, as far as my experience goes, your friend has little chance for recovery from the insurance company. If they do pay him or are forced by court procedure to pay him, will you let me know about it?'

I have not heard that any payment or settlement was made.

AN FCZEMA CASE

A Southern radiologist of considerable prominence wrote me. I have been sued, charged with burning a man's legs with X-rays. I would like to purchase a good

book on the subject, for the benefit of my lawyers. What have you to suggest? I understand that you have made an exhaustive study of the subject. Have you anything that you prepared that I could get?"

My reply read "I am in receipt of yours of the 21st and replying will say that I wish you had given me more particulars relative to the matter in hand, and then I might have advised you more intelligently, from the very start.

"However, I take it that there will be plenty of time for you to send me such details as seem advisable, for me to advise you, before the case comes up for trial.

"Your understanding that I 'have made an exhaustive study of the subject' is correct. I have studied the subject because I like it, and you know when we like a thing we go into it thoroughly. I would *rather* help fight a malpractice suit *than eat*. But as every malpractice suit or claim is as different as is every clinical case, every one must be handled differently, and without a pretty good knowledge of the entire matter little valuable advice can be given, unless we have made an examination. I am enclosing (on another sheet), a list of questions, which, when answered, will give me sufficient insight to say something about how best to prepare your defense. You must know that every case, no matter how apparently trivial, *must be well prepared*, in order to win. Without proper preparation, the best and surest case may be lost. I do not want to brag but I am sure that your attorneys will say that the man who drew up the questions on enclosed sheet knows something of planning a fight in court.

'You ask for the name of 'some good book on the subject'. I am sorry to say that I know of none that I think is really good enough to completely cover it. A recent book gotten out by the Macmillan Co., entitled 'Courts and Doctors,' by Lloyd Paul Stryker, late attorney for the New York State Medical Society, is about the best that I know of. It is inexpensive and I advise you to get it. If you want, I can order it here for you. George M MacKee's 'X-rays and Radium in the Treatment of

here I do not know what my charges will be for coming here

Dr M J Hubeny was sworn, qualified and testified, verifying the testimony of the writer in practically every detail

The attorneys for the railroad company felt practically sure that the plaintiff would secure a verdict, and advised settlement. This was done. It was however just another instance of a hold-up, "because one person had a gun and the company had the money." Such instances of "hold-up" are more common in the courts than on the highways. A big corporation or rich individual practically never gets a square deal before a jury.

IS A ROENTGEN DERMATITIS ON A PHYSICIAN'S HANDS ACCIDENTAL?

A little more than a year ago I had an inquiry from one of the best known radiologists in Canada, reading as follows: "There is a young doctor in my district who has a small office x-ray equipment. During the past ten years he has frequently abused his hands by frequent exposures without proper protection. As the result he has developed a radiodermatitis with multiple keratoses and several ulcerations. During the past six months he has spent a great deal of time in the East, at which time he had two fingers amputated as the result of the extensive tissue involvement."

"This young man carries an accident and sickness policy in an insurance company. He interviewed me recently with a view to obtaining an opinion as to whether I thought I could say that his incapacity was the result of multiple accidents. What is your opinion? Are there any cases on record of which you have any knowledge whereby the courts have ruled that injury to the operator's person was considered as accidental and whereby the insurance company have assumed the responsibility and liability?"

My reply was as follows: "Replying to yours of the 21st inst relative to the doctor who had exposed his hands to the x-rays and developed a radiodermatitis, and as to the accident liability, will say that much

depends upon the wording of the insurance contract or policy.

"Personally, I cannot see how any such injury, by even the greatest stretch of legal interpretation, could be considered as an accident or due to accidental means.

"The legal definition of what is an accident or accidental has not often been the subject or theme of leading high court decisions, as far as I know, but such as I do know of, state it in a fairly clear manner. One such (Lickleider vs Iowa State Traveling Men's Assn, 166 N W R, 363) says that an accident is 'an event from an unknown cause or an unexpected event from a known cause, a thing done or disaster caused without design or intention, an unusual or unexpected result attending the performance of a usual or necessary act'.

"That decision further goes on to state that 'An injury happening to an insured person through his own voluntary act, is not an accident nor is his hurt to be attributed to accidental means and it is true, that if the insured does a voluntary act, *the natural, usual and to be expected result of which is to bring injury upon himself, then a death so occurring is not an accident in any sense of the word, legal or colloquial*'.

"Now then, you know and I know, and the other man should have known, and the insurance company will have no difficulty in proving by a great preponderance of the evidence (or at least testimony), that such an injury as a radiodermatitis is *not* the unusual or unexpected result of the exposures, but *is in fact, the usual and expected result of the exposures*, even though the injured man did not know that, so it seems to me that the element of accident is and should be eliminated and discarded.

"But, it may be, that because this man's injury was without design on his part, or that it happened without the concurrence of his will, that your Canadian courts may consider that part of the injury as accidental, but I do not believe that he would have any chance of proving the injury as accidental in the United States.

"I am enclosing a reprint which contains the above case decision, as well as some

others that may be of interest I call your attention to *vs* case, in which I was involved as an expert and helped plan the prosecution of the case for the widow I knew her husband, Dr , very well personally and took a great deal of interest in it and, of course, derived a great deal of pleasure and satisfaction out of the final victory for Mrs , besides receiving considerable praise from several sources as the result of my activity in the case. The insurance company fought hard and long, using all the tactics which high priced lawyers can and will use. They had me on the witness stand three times and grilled me, or rather tried to grill me, to the extreme, but I was sure of my ground, and did not contradict myself once in the hours that the lawyers propounded their questions. I did not get a nickel for my services, but the experience was worth much to me in the satisfaction of a deed well done and justice furthered.

"Another case which might be considered to apply in the one you mentioned, is *Hewig vs Business Men's Accident Assn of America* (234 S W R , 853). That is a Missouri Supreme Court decision, which holds that the insurance association was not liable when the plaintiff, a *physician*, was not immediately disabled by an accident.

"Another case, in which the court said that an occupational disease is not an accident, might be applied. That is *Peru Plow and Wheel Co vs Industrial Commission et al*, an Illinois case reported in 142 N E R , 546.

"I am sorry that, as far as my experience goes, your friend has little chance for recovery from the insurance company. If they do pay him or are forced by court procedure to pay him, will you let me know about it?"

I have not heard that any payment or settlement was made.

AN ECZEMA CASE

A Southern radiologist of considerable prominence wrote me "I have been sued, charged with burning a man's legs with X-rays. I would like to purchase a good

book on the subject, for the benefit of my lawyers. What have you to suggest? I understand that you have made an exhaustive study of the subject. Have you anything that you prepared that I could get?"

My reply read "I am in receipt of yours of the 21st and replying will say that I wish you had given me more particulars relative to the matter in hand, and then I might have advised you more intelligently, from the very start.

"However, I take it that there will be plenty of time for you to send me such details as seem advisable, for me to advise you, before the case comes up for trial.

"Your understanding that I 'have made an exhaustive study of the subject' is correct. I have studied the subject because I like it, and you know when we like a thing we go into it thoroughly. I would *rather* help fight a malpractice suit *than eat*. But as every malpractice suit or claim is as different as is every clinical case, every one must be handled differently, and without a pretty good knowledge of the entire matter little valuable advice can be given, unless we have made an examination. I am enclosing (on another sheet), a list of questions, which, when answered, will give me sufficient insight to say something about how best to prepare your defense. You must know that every case, no matter how apparently trivial, *must be well prepared*, in order to win. Without proper preparation, the best and surest case may be lost. I do not want to brag but I am sure that your attorneys will say that the man who drew up the questions on enclosed sheet knows something of planning a fight in court.

"You ask for the name of 'some good book on the subject'. I am sorry to say that I know of none that I think is really good enough to completely cover it. A recent book gotten out by the Macmillan Co, entitled 'Courts and Doctors,' by Lloyd Paul Stryker, late attorney for the New York State Medical Society, is about the best that I know of. It is inexpensive and I advise you to get it. If you want, I can order it here for you. George M MacKee's X-rays and Radium in the Treatment of

Diseases of the Skin' (Lea & Febiger, 1927 Edition) contains about ten pages on 'preparation for trial' and 'defenses' that are pretty good "

The questionnaire that I sent (with this physician's answers) follows

Age of patient? 36 Sex? Male

Disease or condition treatment was given for? Eczema of lower legs

How long standing? About three years' standing

Technic used and dates of treatment? 50 kVp 2 ma, 16 inches FSD, 7 minutes [Note He failed to mention filter] Nine treatments in all from April to October, 1925, two to four weeks apart

Date of last treatment? Oct 22, 1925

Have you complete and accurate records of the treatments? Yes

When were these records made? At time of treatment By whom? By me

By whom were the treatments administered? By me

What was the effect of the treatment? No visible manifestation

When did patient first complain of injury? The night of the last treatment

Of what did patient complain? Excruciating pain in the parts treated

Have you or anyone in your employ or association admitted to the patient, his relatives, or attorney that an error has been made, or in other words have you (or has anyone for you) in any way acknowledged liability for the alleged injury? No

Are you insured against malpractice? Yes

With what company? U S F & G Co Amount? \$5,000.00 Have you notified the insurance company? Yes

Does plaintiff in this case know that you are insured? Yes

If reported to insurance company or state society, will you send me a copy of your report to them? I made a verbal report at last meeting

[Note He answered this question only in part]

Can you send me a copy of plaintiff's bill of particulars or his charges against you? Yes

Has plaintiff paid his bill? Yes Any part of it? All Does he dispute the bill? No

Has he refused to pay it? Paid it Has he made any promises to pay it? [Blank]

Have you any witnesses to a promise to pay the bill? [Blank]

What is occupation of plaintiff? Farmer

Has he a good reputation? Yes Is he liked or disliked in his community? I think he is liked

Had he been to other physicians before you treated him for the condition complained of? Yes

Has he been to other physicians since his alleged injury by you? Yes

Does plaintiff belong to any important fraternal organizations? Mason

Is he a lodge brother of yours? Not in same lodge

Will the trial of the suit come up in your home town? Yes

How soon? Next October When was suit filed? Last month

How do you stand in your home town among the laity? Good, if I tell it

How do you stand in your home town among physicians? Good, if I tell it

Do you now hold or have you held any offices in your local or state medical society? I am on Jurisprudence Committee in state society

Do you now hold or have you held any political office? No

Will any of your local confrères appear as witnesses against you (as witnesses for the plaintiff)? No Are such as will do so, of high standing? [Blank]

Will any of your local confrères appear as witnesses for you? Yes

Have you made any arrangements for expert witnesses? Yes If you have, who are they? Dr W F H , of New Orleans, and others

from Memphis Do you own the Hospital? No If not, what is your position there? I am radiologist

Is that hospital classed as a charitable or municipal hospital? The hospital was, at the time of his treatment, owned by a stock company, for profit It is now owned by a stock company but 'non-profit'

Upon receipt of the foregoing I replied "From a mere scanning of the information you gave me in the questionnaire, it is easy to see that your technic is well within the bounds of safety, even though you did not inform me as to whether you used any filtration or not There is ample in the information to show a proper application of the radiation, and as radiation is proper treatment for eczema, you should have no difficulty in proving that to the jury and also that it is a physical unlikelihood that the patient was damaged by your treatment In fact, I feel sure that you were not guilty of malpractice, and that you should not have very much difficulty in convincing a jury that you were not guilty, even if the case cannot be taken from the jury by the presiding judge, which seems altogether likely

"But with all this, it is sometimes not

understandable how a jury of apparently sane and sensible men, will render a verdict for the plaintiff in such cases. I have seen verdicts rendered in the face of the most evident and clearly manifest proper practice and good treatment, given against some of the highest thought of and most erudite physicians. So you must prepare to fight it to the last ditch, as if you were sure of losing unless you fought with the last erg of your strength. Eternal vigilance is surely the price of liberty here, more than in any other place I know of."

This suit was settled out of court for less than it would have cost to try it. While it was a bad precedent to make in settling a malpractice suit, I can hardly blame those interested.

X-RAY TREATMENT OF A SYPHILITIC RASH¹

About eight years ago, a physician in a north-central State wrote me that he was being sued for malpractice because of alleged injuries produced by the x-rays. He also stated that he had not notified his insurance company.

I sent him the usual questionnaire so that I might have more or less complete information of matters as they were, from his standpoint, and upon its receipt, wrote him as follows:

"In regard to the suit you say is pending, will say that, as far as I can determine, from the meager particulars you gave me regarding the technic of the treatment, you have 'not a leg to stand on' as regards an effective defense in the affair.

"While I am radically against settling such cases, there is, from your description, sufficient indication that the x-rays have produced an injury, and as the x-rays are not an approved method for the treatment of the skin manifestations of lues, you will probably have a difficult time to convince any judge or jury that you did right in treating plaintiff in the manner you describe.

"If you had either shown proper skill or exercised due care in the application of that skill in the treatment of the case there might have been some hope for a good de-

fense, and a favorable verdict likely in the case, by alleging or claiming hypersensitiveness of the skin or idiosyncrasy or possibly neglect to follow your instructions (as you allege) by the plaintiff, etc. These items would, however, be futile, in the presence of the fact that you treated him for a condition wherein your methods were not in accord with the usual, customary, and regular practices as followed by recognized medicine.

"In reply to your question as to whether plaintiff 'has any damage when he didn't return for observation or treatment,' will say that 'returning for observation or treatment' *would not have made an iota of difference in the end-result. You could not in any way have modified the end-result after the treatment had been administered, no matter what you might have done.* In other words, the damage was done at the time of your administration of the treatment, and *not* by the patient's failure to return. The greatest error was made by your treating the patient *at all* for a luetic rash, in the first place, and in not using filters in the second place. Filtration is necessary in cases where repeated dosage is applied on the skin. It probably would have, as it generally does, prevented skin atrophy, which is what this man has, from your description.

"So, in view of these decidedly damaging points, it seems to me that the wisest course for you to pursue will be to settle as cheaply as you can, and be more careful in the future.

"If you had been paid cash for this treatment, you would probably not have been sued. Lawsuits are frequently the result of a long delayed demand for payment. I have had one myself that had been hanging fire for several years—and was absolutely unjustified as far as injury is concerned—thrown out of court recently. That suit was started because I handed the bill for a balance due on my fee, to a lawyer for collection.

"You are certainly unfortunate in not having read your contract for malpractice insurance, so that the insurance company

would protect you. That again is, of course, your own fault, although, in my opinion, the sharp practice of the insurance company in refusing to defend you in this case because you had delayed reporting the filing of the suit is *inexcusable*. I know that the company where I carry my insurance would not act in that manner.

"I am sorry that I am unable to give you any advice that will help you, heat this case, but if you finally decide to fight it, I will be glad to outline such points and manner of defense as I can for you. In that event, you must, of course, let me have the exact technique you used, dates, and all the particulars you have in the matter. Of course, your attorney should have all the dealings with the claimant or plaintiff, so that you do not compromise yourself, in offering a settlement.

"If your attorney is inclined to fight this case on its merits, show him this letter and see what he says after reading it.

"I will be glad to learn from you the final outcome of this case, and trust that it will not cost you very much."

Evidently this physician did not like the tone of my letter, because he failed to reply. I wrote him a follow-up letter about a year later, but up to this time have not heard how the suit was disposed of. If he reads this, and I have reason to believe that he will, I wish he would inform me.

A PLANTAR CALLUS "ET UX" CASE

Just about ten years ago I was consulted by a very good friend from central Iowa relative to my aiding him in defending two damage suits. The physician defendant was a man of highest standing and attainments, a past-president of his state medical organization, and one of the early users of the roentgen rays in his vicinity.

The plaintiffs in the suits were a lawyer and his wife, the latter having been the patient and alleging that she had been damaged by the physician defendant because of roentgen treatment to a large plantar callus.

The bill of particulars set up charges that the x-rays were not an approved method of

treatment for the condition, that because of the treatment, infection occurred under the callosity, that much time had been lost, atrocious and agonizing pain resulting, and necessitating an expensive trip to a large clinic, where it was alleged (but not proven) that a diagnosis of x-ray burn had been made, etc., *ad nauseum*, as only a lawyer can describe in polysyllabic phraseology, and for all this, the good doctor should pay the trifling sum of \$20,000.

The husband (an attorney) alleged that his mental anguish, the loss of his wife's companionship, etc., was worth another \$20,000, so he also sued the doctor for that amount.

Both sides of these suits were well prepared and well represented by plenty of legal talent and the trial was consequently long drawn out by the introduction of much unimportant testimony, as well as frequently interrupted by extended legal arguments in efforts to sustain or controvert objections raised by one or the other litigant.

I attended the trial as a consultant and expert witness for the defendant physician. My testimony was to the effect that roentgen rays were an accepted and approved method for the treatment of plantar callosities, that the dosage applied was safe, proper, and in every way correct and that if any infection or consequent abscess occurred under the callus, it was in spite of the correct roentgen treatment and not because of it. None of my testimony was disputed, except by the plaintiff and her co-plaintiff husband, and that was only by hearsay statements (which they managed to sneak in) of what they alleged was told them at the big clinic.

After dragging through four days (which should have been accomplished in one day), the jury rendered a verdict for the physician defendant.

The next day, the suit brought by the lawyer husband of the patient wastried and ended in another verdict for the defendant.

The appreciative defendant, a friend of the writer for many years, wrote me—in part—as follows: "I am told that my

friend, Judge M (one of his attorneys who had telegraphed me 'Jury decided in favor of Dr H We are much gratified and are very grateful to you for your services and assistance'), has already sent you word of our victory in the suit

"Of course, I am pleased to have it come out so It seemed to me that the trial judge was fair in his charge to the jury, although I could not claim that our side received any special favors The entire case, of course, depended upon the question as to whether there was an x-ray burn and, if so, was it due to my negligence, but your testimony was so convincing and given in a manner that every one present felt that you knew what you were talking about My attorneys say that they like the way you talk to the jury

"I want to thank you most sincerely for the great favor of coming to at great inconvenience, loss of time, etc., to assist me Your services were invaluable The attorneys used your testimony with confidence, in their arguments both for a directed verdict—which we did not get—and to the jury

"This was my first experience in court, except as a witness, and after spending a good part of three weeks in the trial, I must say that I am not specially taken with it "

Both of these cases were appealed by the plaintiffs and the Supreme Court of Iowa confirmed the judgments of the lower court

The winning of these two cases gave me more pleasure than did the winning of any other suits I have been interested in, *my own included*

THE BIG LAWYER WAS FLUSTERED

In 1908 I was a witness for the State in a rape case and was being cross-examined by

a very prominent attorney with whom I was quite well acquainted This attorney was a very large man and was known to be extremely abusive to opposing witnesses Our acquaintance did not prevent his applying some of his severest abuse to me

He had asked me some question to which I had replied, "I do not know," at which he pretended to become very much incensed Roaring loudly at me, he shook his long index finger under my nose, so close that I could feel the wind stirred up by it, he continued in his apparent attempt to embarrass and browbeat me

Unabashed and not at all afraid, I stood this for quite a while Then I gently pushed his hand away from in front of my face and quietly but distinctly said, "Mr O'D , if you do not take your finger away from under my nose, I will bite it "

My remark and the accompanying action caused all present to shout with laughter and somewhat startled the big, blustering lawyer After the bailiff had restored order, I said, "On second consideration, Mr O'D , I do not believe that I will bite your finger It is too dirty," which again caused those present to be convulsed with laughter

I was excused and the court declared a recess The big lawyer affectionately put his arm across my shoulder and we walked out together He assured me that he had never been so disconcerted in his life and he told the story as a good joke on himself several times in my presence

But, in the final summing up of the testimony in the case, my friend called the attention of the jury to the fact that one of the State's witnesses was so hostile to his client that he threatened to bite his finger

(To be continued)

PULMONARY SYPHILIS IN ADULTS, WITH REPORT OF A CASE

B₃ W W ROBINSON, M D , *Memphis, Tennessee*

IT IS generally agreed by internists and pathologists alike that the lungs of the adult are relatively immune to syphilitic infection. This is a rather strange concept of a disease as protean in its symptomatology and as diverse in its pathologic manifestations as is syphilis. Hutchinson has remarked that syphilis has long been said to constitute in itself an epitome of pathology. Yet it appears that it rarely attacks the lungs of adults. While it is true that it is seldom recognized or suspected during life, undoubted cases have been reported. In 2,800 autopsies at the Johns Hopkins Hospital (1) there were 12 cases found, but only four of these in adults. Three of the 12 were recognized clinically. Among 20,000 patients admitted to the Munster Clinic, Krause (2) observed only five cases. Dienst (3) has reported five cases, two of which were unquestionably authentic. Golden (4) has described three cases of massive interstitial fibrosis of one whole lung occurring in syphilitic individuals, which condition had existed for several years, and in which there was cavitation with retraction of the heart and other mediastinal structures. Watkins calls attention to the possibility of this type of case being the result of a syphilitic tuberculous symbiosis. Ordinarily, in uncomplicated syphilis of the lung, cavitation occurs only in the terminal stages as a result of bronchial dilatation and bronchiectasis, and calcification is never noted. Moreover, it should be remembered that such fibrosis may develop from other inflammatory processes. It should not be classified as of syphilitic origin unless spirochetes are demonstrated in the lesions. It does not compare with the massive interstitial consolidation, or white pneumonia of infants, in which there is ample pathologic evidence of its syphilitic etiology. Allison (5) has reported a case of irregular consolidation of the left lower lobe, present for several years without

symptoms or signs in a syphilitic, which was undoubtedly proven by its complete disappearance in a few weeks after institution of specific therapy. Hartung and Freedman (6) have reported three cases, one of miliary gummas, and two of the solitary variety, all of which are authentic. These clinicians specify certain criteria for a diagnosis of syphilis of the lungs which are well worthy of mention. The patient must have a syphilitic history, with the signs and symptoms of a chronic, stubborn, progressive pulmonary lesion, a sputum negative for the presence of tubercle bacilli on repeated examinations, positive serology, and a definite lesion demonstrable roentgenographically, which should show an unquestioned response to anti-syphilitic medication. The diagnosis is made more positive if the lesions are more extensive than the condition of the patient would indicate.

There are no pathognomonic lesions in syphilis of the lungs. They are a late manifestation of the disease, usually appearing two to three years after the initial infection. Whereas they are said to have a predilection for the middle lobe of the right lung according to Kohler (7), or according to other authors they preferably affect the hilum zone of one lung-field, or the base of one lung, the distribution of the lesions and their appearance is quite variable. In a disease giving rise to such diverse pathologic processes there can be no typical roentgen picture. Roentgenologically, the following three types of lesions have been described.

(1) According to Assmann, there is a generalized thickening of all the bronchial markings, studded with minute "knobby" enlargements, radiating out from the hilum into one or both lung-fields, and producing a characteristic fan-shaped effect, a diffuse interstitial fibrosis of the bronchial tree. If bilateral, this lesion may be confused with the infiltrative type of metastatic



Fig 1 Original roentgenogram of chest. Note lesions in left upper and lower lobes, and their similarity to lobular tuberculosis and abscess formation. The infiltration in the lower lobe shows a rarefied center.



Fig 2 Roentgenogram of chest taken ten days after the fourth dose of neosalvarsan. Note the marked regression of both lesions.

malignancy. If unilateral, primary bronchogenic carcinoma of the infiltrating type must be excluded. The process may be confined to comparatively small areas, found more especially in the hilus of the lung. There is marked cellular invasion of the interstitial connective tissue, the walls of the vessels and bronchi, and later a hyperplasia of the connective tissue and desquamation of the epithelium of the alveoli.

(2) Gummas of the lungs, which may be miliary and multiple, or solitary discrete masses several centimeters in diameter, appearing as nodular areas of increased density usually near the hilus or even in the periphery of the lung-field. In the early stage of development of the latter, a delimiting zone of pneumonitis is formed about them, which is replaced in the later stages by a fibrous connective tissue capsule. They may become necrosed, demonstrated by an area of rarefaction in the central portion of the nodule. Instead of necrosis fibrosis may occur. In the

early stage of the solitary type, especially if situated in the periphery of the lung, the condition may be confused with a lobular tuberculosis or abscess formation. In the late stage of encapsulation, and located near the hilus, it resembles a primary malignant tumor. The miliary gummas may be mistaken for metastatic malignancy.

(3) The diffuse lobar form, which is occasionally described as a distinct entity, should not be classed as such because the lesion itself is probably in the primary bronchus, and the picture is one of a secondary massive atelectasis resulting from a broncho-stenosis.

Symptoms and signs may be absent. They are quite variable, and are usually dependent on the nature and extent of the lesion. They may be manifested by a dry, trivial cough, or the expectoration of a muco-purulent sputum, with febrile reactions and all of the signs of an active tuberculosis. A sudden and severe hemoptysis may be the first symptom. In

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polymorphonuclears, 48 per cent, lymphocytes, small, 30 per cent, large 20 per cent, eosinophiles, 2 per cent. The blood Wassermann and Meinicke turbidity reactions were four plus positive.

Roentgen examination of chest (Fig 1) The right lung-field was essentially negative, except for a moderate thickening and widening of the hilum zone. In the periphery of the upper left lobe, in juxtaposition to the axilla, there was a definite area of increased density and infiltration 4.5 cm in diameter, with hazy, irregular margins. In the base of the lower left lobe adjacent to the cardiac shadow there was a similar area of increased density and infiltration with a rarefied center. The left hilum showed much thickening and widening, with extension along the epibronchus, but more especially along the infrahilum. A few calcified glands were noted in either hilum. The tracheal, heart, and diaphragmatic shadows were normal.

Diagnosis Late stage of syphilis, with the probability of infection of the left lung, gummatous in character, involving the upper and lower lobes.

Treatment Four doses of neosalvarsan of 0.6 gram each were given at weekly intervals. No other treatment of any kind was used. There was a severe reaction to the first two injections, after which it was noted that the patient had no further rise in temperature. The cough was much better and after the fourth treatment all cough had subsided. There was a striking improvement in all of the symptoms. The syphiloderm was rapidly disappearing.

Ten days after the last treatment, the

chest was again roentgenographed (Fig 2). Both of the lesions of the left lung showed marked regression. Only a vague opacity remained in the periphery of the upper left lobe indicating the site of the original lesion. In the lower left lobe only a few linear striae of increased density marked the location of the previous infiltration.

An intensive regimen of anti-syphilitic treatment was instituted. There were no further symptoms or signs referable to the chest. Roentgenograms made several months later (Fig 3) showed both lung-fields to be entirely free of any pathology.

COMMENT

An undoubted case of pulmonary syphilis involving the upper and lower lobes of the left lung has been presented. This case conformed to all of the criteria laid down for a diagnosis of syphilitic infection of the lungs. The response to specific therapy was prompt and lasting.

Attention is directed to the possibility of confusing such cases with tuberculosis or tumors of the lung parenchyma.

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Fig. 1. Roentgenogram of chest taken several months after the treatment was completed. Both lung fields are entirely free of any pathology.

a case of syphilitic tuberculous symbiosis with a sputum positive for tubercle bacilli, most certainly an associated syphilis of the lung would never be suspected. Many cases are therefore entirely overlooked, or confused with tuberculosis or tumors of the lung parenchyma, which fact would tend to account for the rarity of the disease.

Case 1. I. S., negress, aged 36 years, employed as cook in a home, entered the clinic on July 16, 1932, with the diagnosis of pulmonary tuberculosis.

Family history. Irrelevant.

Marital history. Married twice, one child by first husband, aged 20 years, living and well, and one miscarriage by second husband, occurring three years before this examination. Second husband was thought to have pulmonary tuberculosis, but had been treated for syphilis for several years.

Menstrual history. Periods irregular, prolonged, and accompanied by much pain in the lower right quadrant.

Past history. She had had the usual juvenile infections, also influenza in 1918, but no respiratory complications. There

had been attacks of so called rheumatism and myalgic pains in various parts of the body, as well as indigestion for a period of two years. It was significant that she had been treated for syphilis for three years. Inquiry into this gave the impression that the treatment was inadequate in every respect.

Present illness. This began two months before admission to the clinic with severe pain in the left side of the chest, pleuritic in character, irregular fever, ranging from 99° to 100° F, highest in the afternoon, and accompanied by night sweats and the expectoration of a muco-purulent sputum. She felt weak, but her appetite was good, and she continued to work. Apparently she had lost no weight.

Physical examination. This revealed a well-developed, well-nourished, colored female with a typical serpiginous nodular syphiloderm over the posterior aspect of the neck, shoulders, upper arms, lower back, and upper gluteal regions, which was bilaterally symmetrical in its distribution. She stated that this eruption had been present for several months. It was not accompanied by itching. There were shotty glands in both axillæ, also in the inguinal regions. The epitrochlears were not palpable. The deep and superficial reflexes were normal. The eye, ear, nose, and throat examinations were essentially negative but for some hypertrophy of the tonsils. The thyroid gland was not enlarged, and no cervical glands were felt. In the chest, fine, moist crepitant râles were heard in the left axilla and lateral half of the left infraclavicular region, but all other physical signs were negative. Examination of the abdomen showed nothing of any significance, except some tenderness in the lower right quadrant. Pelvic investigation revealed some tenderness in the right fornix with slight induration, uterus of normal size, and in its normal position.

Laboratory examinations. Several sputum tests were negative for tubercle bacilli. No Vincent's organisms were found. A urinalysis showed a mild albuminuria. The leukocytes were 8,400, differential count—

polymorphonuclears, 48 per cent, lymphocytes, small, 30 per cent, large 20 per cent, eosinophiles, 2 per cent. The blood Wassermann and Meimcke turbidity reactions were four plus positive.

Roentgen examination of chest (Fig 1) The right lung-field was essentially negative, except for a moderate thickening and widening of the hilum zone. In the periphery of the upper left lobe, in juxtaposition to the axilla, there was a definite area of increased density and infiltration 4.5 cm in diameter, with hazy, irregular margins. In the base of the lower left lobe adjacent to the cardiac shadow there was a similar area of increased density and infiltration with a rarefied center. The left hilum showed much thickening and widening with extension along the epibronchus, but more especially along the infrabronchus. A few calcified glands were noted in either hilum. The tracheal, heart, and diaphragmatic shadows were normal.

Diagnosis Late stage of syphilis, with the probability of infection of the left lung, gummatous in character, involving the upper and lower lobes.

Treatment Four doses of neosalvarsan of 0.6 gram each were given at weekly intervals. No other treatment of any kind was used. There was a severe reaction to the first two injections after which it was noted that the patient had no further rise in temperature. The cough was much better, and after the fourth treatment all cough had subsided. There was a striking improvement in all of the symptoms. The syphiloderma was rapidly disappearing.

Ten days after the last treatment, the

chest was again roentgenographed (Fig 2). Both of the lesions of the left lung showed marked regression. Only a vague opacity remained in the periphery of the upper left lobe indicating the site of the original lesion. In the lower left lobe only a few linear striæ of increased density marked the location of the previous infiltration.

An intensive regimen of anti-syphilitic treatment was instituted. There were no further symptoms or signs referable to the chest. Roentgenograms made several months later (Fig 3) showed both lung-fields to be entirely free of any pathology.

COMMENT

An undoubted case of pulmonary syphilis involving the upper and lower lobes of the left lung has been presented. This case conformed to all of the criteria laid down for a diagnosis of syphilitic infection of the lungs. The response to specific therapy was prompt and lasting.

Attention is directed to the possibility of confusing such cases with tuberculosis or tumors of the lung parenchyma.

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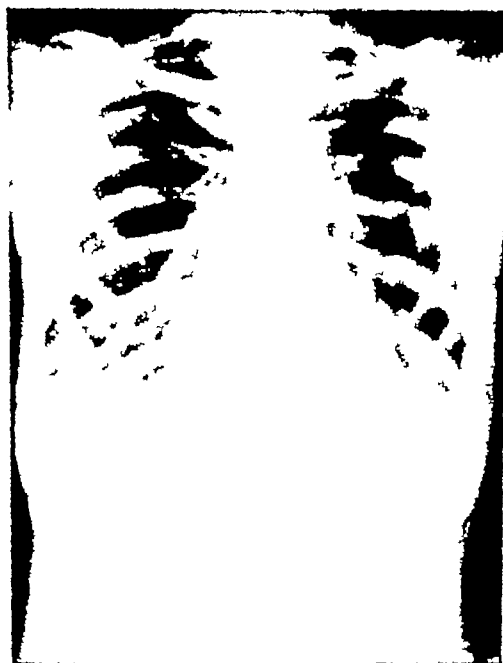


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tween the ages of 35 and the menopause, in which the uterus is not larger than a four months' pregnancy and is not complicated by ovarian cysts or other adnexal disease. Larger fibroids may be radiated if there are contra-indications to surgery, often with brilliant results. However, the larger and harder the fibroid the less chance of complete regression of the tumor and the greater the percentage of poor results. Various complications of fibroids have been given as contra-indications to radiation. Among these are co existing ovarian cysts, pedunculated and submucous fibroids, incarcerated fibroids, desire for future pregnancy, adnexal inflammation, and unusually large fibroids, etc. These are valid contra-indications with the exception of chronic pelvic inflammatory disease. This condition is not considered unsuitable for radiation, on the contrary, this experience includes cases in which radiation has definitely improved the condition and in no case has the inflammation become aggravated by it. Submucous pedunculated fibroids should be removed surgically. Desjardins (2) advises treatment with radium when they are small. Surgical removal followed by radium to the base is, in my experience, good treatment when submucous fibroids are found. Large incarcerated fibroids are best treated by removal. It is noteworthy that few, if any, ovarian cysts have come to operation after this treatment, and one case which, after consultation, was considered to have an ovarian cyst had no trace of it following treatment. Follicular cysts as a rule disappear, and seldom recur. However, a case complicated by the presence of an ovarian cyst of diagnosable size is considered unsuitable for treatment. In cases before the age of 35 a myomectomy would appear indicated or if desired, a temporary menopause by radiation may be induced. Incapacitating dysmenorrhea in women under 35 have been relieved by temporary sterilizing doses. When menses return the patient usually comes again for another treatment. The amenorrhea usually lasts about one year. If there are no bad effects and the patient

so wishes, the second treatment may be large enough to make it permanent. In producing a temporary amenorrhea, the patient should be aware that a permanent amenorrhea may follow, this has not occurred in any case of this series except when done intentionally. It is particularly liable to follow if subtotal removal of both ovaries has been done beforehand by surgery. If myomectomy has been done and symptoms still persist radiation may be used.

The plan of treatment used in this series is, first, to select suitable cases by careful history and physical examination. These include fibroids, which are intramural or subserous and not pedunculated, in patients between the ages of 35 and the menopause. Cases with ovarian cysts or fibroids over three months' pregnancy in size should be excluded, unless surgery cannot be done. The symptoms usually are menorrhagia without intermenstrual spotting. In the second group will be cases of menopausal dysmenorrhea, these may have fibroids or subinvolved uteri, and the latter may be normal in size. The third group will be fibroids in patients under 35 years of age. An occasional case may be treated as young as 33. A temporary amenorrhea may be produced by a half dose, but a myomectomy or radium in the uterine canal would appear preferable. Patients under the age of 35 with a severe menorrhagia or dysmenorrhea may be given a temporary sterilizing dose.

The treatment consists of x-ray therapy applied through four ports, over the pelvis. The factors are as follows: 200 kv filtered through 0.5 mm Cu and 1 mm Al at 50 cm distance are used to deliver from 600 to 650 r units per 15 sq cm field, and the central beam in each field is directed toward the ovaries. The total dose is given on two three or four successive days. The case is then observed by monthly examinations until the uterus has returned to approximately normal size, the patient is then discharged. If there is an abnormal response to radiation therapy, prompt surgical consultation is sought and a curettage is done to rule out corpus cancer. If found

RADIATION THERAPY OF FEMALE PELVIS FOR BENIGN LESIONS

WITH REPORT OF 396 CASES

By VERNOR M. MOORE, M D , *Grand Rapids, Michigan*

THE radiation treatment of benign uterine hemorrhage, at or near the menopause, is not a new procedure. Many thousands of cases have already been reported, so that the status of radiation in the treatment of these conditions is known with fair accuracy. This report concerns the radiation treatment of 396 cases of uterine hemorrhage, with an analysis of the results, together with certain observations based on this experience. The discussion is not meant to be a comparison of radiation, surgery, and medical treatment. Some cases are found suitable for one method of treatment, some for another, and one may succeed in cases in which another has failed. It is, rather, an effort to evaluate the degree of success using radiation treatment alone.

Uterine fibromyomas are present and probably contribute to uterine hemorrhage in the greater percentage of cases. Klob (1) estimates that uterine myomas are present in 50 per cent of all women over 50 years of age, and in 20 per cent of all women over 35. Ewing states that "the essential etiologic factor in uterine myoma is an embryogenic disturbance of the structure of the uterus due to a disturbance in the formation of the tubes, uterus, and vagina from the Mullerian ducts which split off the Wolffian bodies at an early period and fuse to form the genital tract. The relation of certain early myomas to the blood vessels of the uterus has long impressed many observers and suggested that uterine myomas arise from a disturbance in the growth of blood vessels from the walls of which the uterus and vagina originally receive their muscular tissue. Rosger, Sobotta, and others have traced the development of early myomas from the vessel walls and concluded that the blood vessels control the origin and growth of uterine myomas."

Radiation acts chiefly on the ovary and in adequate doses represses the formation

of the Graafian follicle. It so acts because the germinal epithelium is among the structures most sensitive to radiation. The ovary as a whole suffers little damage, and after radiation appears normal in size and color. Nicotra (3) states that a histological examination of the uterine mucosa one or two months following radiation was normal. There is undoubtedly some action on the fibroid itself. Zimmern and Brunet (4) found the tumor to regress in response to treatment after the menopause, also after menses were again resumed. Furthermore, cervical stump fibroids respond well to x-ray therapy, even after the removal of the uterus and ovaries. There is probably very little action on the blood vessels in the dosages employed, and the action on fibroids probably does not depend on blood vessel action.

The effect is distinctly different in the event that the x-ray or radium is used. The radium is usually placed in the uterine canal, and its greatest action is local and fades off rapidly a few centimeters away from the source. On the other hand, x-rays treat the ovaries and the whole pelvis fairly evenly, and do not produce the caustic effect which tissues adjacent to radium receive. Desjardins (2) states that either the x-ray or radium is a specific for benign uterine hemorrhage at or near the menopause not related to fibromyomas. Radium placed in the canal may produce bowel injury if there should be adhesions holding the bowel to the uterus. Action with radium great enough to affect the ovary produces more damage to the uterine wall than appears necessary. Most radiologists who have both x-rays and radium at their disposal prefer x-rays on account of their more gentle action and their greater effect on the ovary (6).

In general, the indications for radiation are in those cases of hypermenstruation be-

tween the ages of 35 and the menopause, in which the uterus is not larger than a four months' pregnancy and is not complicated by ovarian cysts or other adnexal disease. Larger fibroids may be radiated if there are contra-indications to surgery, often with brilliant results. However, the larger and harder the fibroid the less chance of complete regression of the tumor and the greater the percentage of poor results. Various complications of fibroids have been given as contra-indications to radiation. Among these are co existing ovarian cysts, pedunculated and submucous fibroids, incarcerated fibroids, desire for future pregnancy, adnexal inflammation, and unusually large fibroids, etc. These are valid contra-indications with the exception of chronic pelvic inflammatory disease. This condition is not considered unsuitable for radiation, on the contrary, this experience includes cases in which radiation has definitely improved the condition and in no case has the inflammation become aggravated by it. Submucous pedunculated fibroids should be removed surgically. Desjardins (2) advises treatment with radium when they are small. Surgical removal followed by radium to the base is, in my experience, good treatment when submucous fibroids are found. Large incarcerated fibroids are best treated by removal. It is noteworthy that few, if any, ovarian cysts have come to operation after this treatment, and one case which after consultation was considered to have an ovarian cyst had no trace of it following treatment. Follicular cysts as a rule disappear, and seldom recur. However a case complicated by the presence of an ovarian cyst of diagnosable size is considered unsuitable for treatment. In cases before the age of 35 a myomectomy would appear indicated or, if desired a temporary menopause by radiation may be induced. Incarcerating dysmenorrheas in women under 35 have been relieved by temporary sterilizing doses. When menses return, the patient usually comes again for another treatment. The amenorrhea usually lasts about one year. If there are no bad effects and the patient

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radium treatment, hysterectomy, or both are done. Most of the failures in this series have been due to failure to recognize carcinoma of the fundus. These may occasionally be overlooked even after a diagnostic curettage has been done (5). Theoretically, these cases should be excluded from the series, because by having a routine diagnostic curettage beforehand the majority of them should be found. Our reason for not having it done is largely on financial grounds, as it has been more expensive to the patient to have it done than the entire cost of radiation. We would recommend it in every case, to find the two or three cases of cancer in each hundred admissions if the chances for recovery in these two or three were seriously jeopardized by a two to three months' delay. However, carcinoma of the fundus grows slowly and is not prone to metastasize early, and radiation should tend to repress its growth even though inadequate in amount. For these reasons, if no unusual complications or suspicious symptoms are present, these cases have been treated first, and surgical intervention has followed as soon as any suspicions were aroused. Needless to say,

if there is pain, intermenstrual spotting, or cachexia the diagnostic curettage is done before any radiation is attempted.

After radiation, the patient has not as a rule been more incapacitated than she was prior to treatment, and usually attends to her regular duties without interruption. After radiation, the patient usually experiences a moderately tired feeling, which wears off within a week or so. In some cases radiation sickness may be severe, but these symptoms are seldom alarming and in none has it been considered serious. The menorrhagia is not influenced for at least a month, in fact, many cases show an exaggerated menstrual flow at the next period. This is usually controlled by rest in bed. Transfusion is seldom, if ever, necessary. Some cases will not menstruate again after the treatment but the majority of cases will have one period and occasionally two. The fibroid does not show much reduction in size until one month after the last menstrual period. From then on there is a gradual reduction in size for several months.

No radiation accidents have occurred and no mortality attributable to radiation has resulted. Death has followed subse-

TABLE I—RESULTS IN FIBROMYOMAS AFTER RADIATION

Size fibroid	Cases	Health good pelvis normal after radiation	Patient well last report	Carcinoma uterus	Surgery later	Good result
Walnut	23	18	3	1	1	91 3%
Egg	6	5	1	0	0	100 0%
Tennis ball	6	5	1	0	0	100 0%
Orange	42	34	7	1	0	97 6%
Grape fruit	59	46	8	3	2	91 5%
Larger than grape fruit	9	7	1	0	1	89 0%
Size not stated	99	79	14	3	3	94 0%
Total	244	194	35	8	7	94 6%

TABLE II—RESULTS AFTER RADIATION IN MISCELLANEOUS GROUP

	Cases	Health good, pelvis normal after radiation	Patient well last report	Recur- rence	Carcinoma uterus	Surgery later	Good result
Dysmenorrhea	86	66	15	1	2	2	94 1%
Endometriosis	1	1	0	0	0	0	100 0%
Endometritis hyperplastic	3	3	0	0	0	0	100 0%
Pelvic inflammation	1	1	0	0	0	0	100 0%
Menopause artificial	2	2	0	0	0	0	100 0%
Menorrhagia	26	20	6	0	0	0	100 0%
Metrorrhagia	19	16 ¹	3	0	0	0	100 0%
Sterilization	4	4	0	0	0	0	100 0%
Subinvolution	10	7	3	0	0	0	100 0%
Total	152	120	27	1	2	2	97 1%

Total all cases

396

¹ One patient died from other causes

quent surgical treatment of cancer of the uterine body due to the progress of the cancer, but whether the omission of a preliminary diagnostic curettage contributed to it is an open question. Certainly the radiation does not contribute to it, but the two months' delay before operation may have

It is well known that the normal menopause does not appreciably change the sexual urge. It should be stressed at this point that radiation does not castrate or de-sex the patient any more than the normal menopause does. Carter (6) says "The internal function of the ovary is not depressed more than by the normal climacteric." The ovaries in cases observed by operation after radiation—and one such case was so observed—are normal in size and color, but no corpora lutea are seen. Radiation prevents ovulation, and as a result the follicular hormone which activates the menstrual cycle is suppressed. This prevents stimulation of the fibroid by the periodic congestion of the menses, and thus reduces its blood supply. If fibromyomas come from the blood vessel walls, as many pathologists believe, it can be seen that this action should result in their regression, extending over varying lengths of time. Cases have been reported in which fibroids continued to regress so slowly that the uterus did not reach normal size until 15 years had elapsed. The average uterus will, if the tumor is not too large, reach normal dimensions in from one to six months after amenorrhea has been produced. If considerable anemia is present, it may take from six months to one year for the blood to regain normal hemoglobin, this depending on the severity of the anemia and the length of the illness. With the cessation of the menses, the blood picture begins to improve and there are as a rule no pelvic symptoms. A leukorrheal discharge may persist for a time but usually soon disappears. Hot flashes appear when the menses cease, they are rarely as troublesome as the natural menopause, and are decidedly less severe than when produced by the removal of the ovaries. Bowing states "We know that the menopause brought on by therapeutic

administration of radium or roentgen rays is less stormy than that produced by castration."

Patients as a rule do not gain in weight. Falls, in a study of 1,000 cases of goiter, found no definite relation between them and fibroids. He believes that hypothyroid patients tend to gain in weight after radiation, but that it can readily be controlled by diet. Other cases do not gain beyond the normal weight which they had before their illness. A few of the cases reviewed gained in weight, but these were hypothyroids, and their weight was easily controlled by diet and thyroid medication. Falls states that cases with fibroids and adnexal disease show no greater incidence of thyroid disease than the normal. The basal rate in 35 of his cases was slightly high, but was not considered significant. Nervousness is generally improved, and one case mentally sick was greatly improved, probably due to improvement in her general health. There is no evidence to show increased nervousness, in fact, the evidence points in the opposite direction.

Various complications which definitely contra-indicate radiation have been given, but these are about as infrequent as unusual complications in pregnancy, and while no records were kept of patients examined but not treated, this experience leads to the conclusion that probably nine out of ten cases are suitable for radiation at some time during the disease. Wintz, at Erlangen, treats 90 per cent of these cases by radiation. French gynecologists, according to Waters, operate on about 70 per cent, but if familiar with radiation divide them equally between surgery and radiation. The results in therapy after the menopause are not gratifying. Fibroids at that time are usually hard in consistency, and will usually go down slowly after repeated treatments, but the results in post-menopausal fibroids are not considered good.

Sarcoma is not thought to develop in fibromyomas as formerly believed, but to grow in another part of the uterus, co-existently or after a fibroid has been pres-

ent Nornworthy states "Reports are published in which fibromas of apparently simple structure have destroyed life. These reports, however, should be accepted with the knowledge that the uterus is occasionally the seat of true sarcomas which in their early stages present symptoms clinically characteristic of fibromyomas. There is no positive evidence on record that innocent fibroids take on sarcomatous degeneration unless complicated by trauma or infection."

While there are numerous contra-indications for radiation, the percentage of cases which cannot be treated is probably not over 15 per cent. This means that out of 100 cases ten will be rejected as unsuitable for radiation, while five will be treated and require surgery later. If a diagnostic curettage is done in every case, the two to four cases of carcinoma of the body of the uterus should be discovered. Our method then gives a poorer group of statistics than if these were excluded beforehand by a curettage.

SUMMARY

Total cases treated	396
Total fibroids	244
Total fibroids well after radiation	94 6%
Total miscellaneous group	152
Total miscellaneous group well	97 1%
Incidence of carcinoma fundus, fibroids	3 3%
Incidence of carcinoma fundus, miscellaneous group	1 32%
Incidence of carcinoma fundus all cases	2 5%
Fibroid cases requiring surgery after radiation	2 8%
Non-fibroid group requiring surgery after radiation	1 3%
Successful results all cases	95 8%

(1) While we have no records of the number of cases that refused treatment on account of contra-indications, it is believed that more than nine out of ten cases referred for radiation have been considered suitable for treatment, and the results, so

far as they could be ascertained, are given on all cases so treated.

(2) This series fails to show any case of cancer of the uterus developing later. The experience in this review leads to the impression that uterine or cervical cancer is rare after such radiation, provided, of course, that it was not present originally.

(3) No primary mortality occurred in this series, and no serious later sequelæ have developed.

(4) It is our firm belief, based on a large number of inquiries, that the sexual lives of these patients are not appreciably changed by the radiation therapy. The term "x-ray castration" is emphatically disliked in describing this form of treatment.

(5) If a diagnostic curettage is done before radiation and cases of corpus cancer eliminated, radiation theoretically should have 25 per cent better results than these statistics show.

(6) Five per cent of cases treated may require surgery, to effect a good result. Surgery may follow radiation without any untoward effects, and the results in cases having both radiation and surgery should be the same as with surgery alone.

(7) In properly selected cases of benign hemorrhage at or near the menopause, x-ray therapy will produce satisfactory results in 95 per cent of cases.

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ROENTGEN EXAMINATION OF THE INTERCONDYLOID FOSSA OF THE KNEE JOINT

By GERHARD DANIELIUS, M D , and LEO FREDERICK MILLER, M D , Chicago

From the Roentgenological Service of Dr Max Cohn, and the Orthopedic Service of Dr Charles M Jacobs, of the Mount Sinai Hospital, Chicago

FROM a clinical standpoint, there are a certain number of cases which present definite intra-articular pathology of the knee joint, in which the roentgen films taken in the usual manner give little or no aid to the clinician. Thus, a view for the visualization of the intercondyloid space and the posterior compartment of the knee joint is essential, the idea was first suggested by B  cl  re, and later by Fri  k, in 1932. There are a number of scattered reports in the foreign literature, but we were unable to find any report in the American literature. The value of this view for the interpretation of intercondyloid pathology is so beautifully illustrated that it warrants its publication.

The anatomy of the intercondyloid fossa and its contents is an aid in understanding the value of this view for visualization of its contents in diseases. The lower third of the femur has two condyles which are separated behind by the intercondyloid fossa, this fossa being tilted at an angle of 60 degrees.

Anteriorly, the lateral condyle is wider and more prominent, while the medial condyle is narrower and longer to compensate for the obliquity of the shaft. When the femur is in the natural position, the inferior surfaces of the condyles are on the same plane and almost parallel for articulation with the upper surfaces on the head of the tibia. The two condyles are continuous in front, forming a smooth trochlear surface for articulation with the patella.

The opposed surfaces of the two condyles form the boundaries of the intercondylar fossa and give attachment to the crucial ligaments. The posterior crucial ligament is attached to the fore part of the lateral surface of the medial condyle, and the anterior crucial ligament to the back part of

the medial surface of the lateral condyle (Morris). The synovial membrane also projects into the joint and is occupied by fat, which serves as a padding to fill the

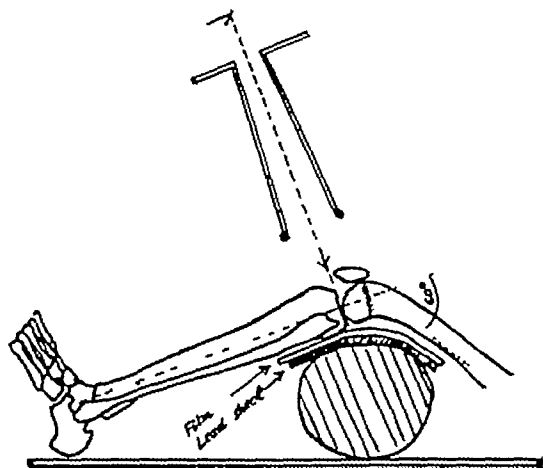


Fig 1 Illustrating the technic for visualization of the intercondyloid fossa

spaces. The chief of these processes—patellar synovial fold, or the ligamentum mucosum—arises from the infrapatella fat mass. This so-called ligament is the central portion of the large process of the synovial membrane, of which the alar folds form the free margins. It extends from the fatty mass below the patella backward, and upward to the intercondyloid notch of the femur, where it is attached in front of the anterior crucial and lateral to the posterior crucial ligament. This ligament becomes tense in flexion and serves to keep the pad in position when there is positive pressure in the joint (Fisher).

A roentgen film taken in the usual manner does not permit the intercondyloid space to be seen, because the anterior portion of the intercondyloid part of the femur is superimposed upon this space. Many

ent Norsworthy states "Reports are published in which fibromas of apparently simple structure have destroyed life. These reports, however, should be accepted with the knowledge that the uterus is occasionally the seat of true sarcomas which in their early stages present symptoms clinically characteristic of fibromyomas. There is no positive evidence on record that innocent fibroids take on sarcomatous degeneration unless complicated by trauma or infection."

While there are numerous contra-indications for radiation, the percentage of cases which cannot be treated is probably not over 15 per cent. This means that out of 100 cases ten will be rejected as unsuitable for radiation, while five will be treated and require surgery later. If a diagnostic curettage is done in every case, the two to four cases of carcinoma of the body of the uterus should be discovered. Our method then gives a poorer group of statistics than if these were excluded beforehand by a curettage.

SUMMARY

Total cases treated	396
Total fibroids	244
Total fibroids well after radiation	94 6%
Total miscellaneous group	152
Total miscellaneous group well	97 1%
Incidence of carcinoma fundus, fibroids	3 3%
Incidence of carcinoma fundus, miscellaneous group	1 32%
Incidence of carcinoma fundus all cases	2 5%
Fibroid cases requiring surgery after radiation	2 8%
Non-fibroid group requiring surgery after radiation	1 3%
Successful results all cases	95 8%

(1) While we have no records of the number of cases that refused treatment on account of contra-indications, it is believed that more than nine out of ten cases referred for radiation have been considered suitable for treatment, and the results, so

far as they could be ascertained, are given on all cases so treated.

(2) This series fails to show any case of cancer of the uterus developing later. The experience in this review leads to the impression that uterine or cervical cancer is rare after such radiation, provided, of course, that it was not present originally.

(3) No primary mortality occurred in this series, and no serious later sequelæ have developed.

(4) It is our firm belief, based on a large number of inquiries, that the sexual lives of these patients are not appreciably changed by the radiation therapy. The term "x-ray castration" is emphatically disliked in describing this form of treatment.

(5) If a diagnostic curettage is done before radiation and cases of corpus cancer eliminated, radiation theoretically should have 2.5 per cent better results than these statistics show.

(6) Five per cent of cases treated may require surgery, to effect a good result. Surgery may follow radiation without any untoward effects, and the results in cases having both radiation and surgery should be the same as with surgery alone.

(7) In properly selected cases of benign hemorrhage at or near the menopause, x-ray therapy will produce satisfactory results in 95 per cent of cases.

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Fig 6-A (left) Irregularities of the tibial spines may be seen at the base of both tibial spines



Fig 6-B (right) Same case Definite fracture line

conus should always be used. We must guard against movement of the leg, because we use an increase in our time corresponding to the lack of the intensifying screens. Figure 1 very clearly illustrates all the details of the technic.

It is not within the scope of this paper to give all of the pathology in our series of cases, but to present a number of typical pathological conditions which are best illustrated by this view.

On the film (Fig 3-A), in the anteroposterior view of the knee joint, the beginning of a liping is seen at the outer border of the tibial condyle and a questionable elongation of the tibial spines. In contrast to this, the special view (Fig 3-B) illustrates clearly all that the anteroposterior view has given, plus some fine calcified striæ and spurs on the inner border of both condyles, which we have to interpret as calcifications in the crucial ligaments. The elongation of the tibial spines is much more pronounced and better visualized in its details.

In the anteroposterior view (Fig 4-A), the joint spaces are clearly seen, and the contours of the articular surfaces are regular. The tips of the tibial spines are hidden by the condyles of the femur. There is an oval shaped, calcified area seen at the base of the tibial spines. There is a lighter area of density in the lateral aspect of the medial condyle. The lateral view aids us little or none in the interpretation of this knee joint.

Looking at the special view (Fig 4-B), it reveals a more extensive pathology, (1) One oval shaped shadow, presenting bone

structure, is seen in the middle of the intercondyloid space, (2) another oval-shaped shadow is seen over the lateral tibial spine, of homogeneous calcium density, which apparently corresponds to the shadow visualized on the other view, (3) elongation and irregularities of the tibial spines, (4) the intercondyloid surface of the medial condyle is markedly roughened. The medial portion of the intercondyloid space is partly filled by an irregularly limited bony projection, arising from the medial portion of the condyle. A gastrocnemius sesamoid is seen. The interpretation is an advanced calcification in the crucial ligaments, and a calcified body in the synovial membrane with a marked osteo-arthritis deformans, which is evident in the intercondyloid fossa.

Figure 5-A shows all the typical signs of a chronic infectious osteo-arthritis of the knee joint. A special view (Fig 5-B) reveals the intercondyloid space to be normal except for the tibial spines, which are flattened. It is quite interesting to compare this view of an infectious atrophic arthritis with that of the osteo-arthritis (Fig 4-B).

Figure 6-A, in the anteroposterior view, reveals a narrowing of the joint space and some irregularities of the tibial spines, which are superimposed with the patella. A definite interpretation of this film is difficult. The lateral view, however, reveals a tearing off of one of the tibial spines which is practically obliterated by the condyles of the femur. The special view (Fig 6-B) definitely shows a fracture line at the base of the tibial spines, and both tips of the spines appear torn.



Fig 2 (*left*) Normal intercondyloid fossa Fig 3 A (*middle*) Anteroposterior view, showing slight elongation of tibial spines Fig 3 B (*right*) Same case There may be seen a definite elongation of tibial spines Beginning calcification of the crucial ligaments

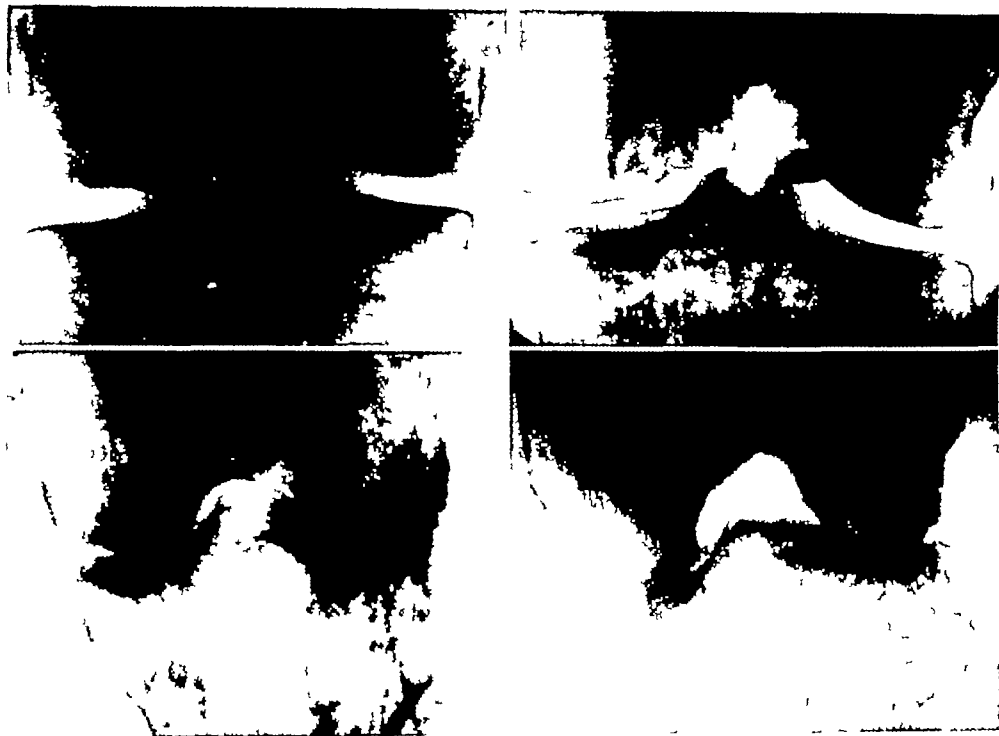


Fig 4 A (*upper left*) Anteroposterior view indefinite as to pathology Fig 4 B (*upper right*) Same case There is marked ossified crucial ligaments with calcified body in synovial membrane Intercondyloid fossa markedly decreased in size, due to osteo arthrosis Fig 5 A (*lower left*) Chronic infectious arthritis Fig 5 B (*lower right*) Same case Intercondyloid fossa normal, tibial spines flattened

times the spines of the tibia are partly covered by this portion of bone. In a special view, a normal knee (Fig 2) reveals the space, semi-circular in outline, with its edges smooth and regular, the spines of the tibia are always visible, and the articulating surfaces of the tibia and femur are seen as well as, or better than, on the ordinary anteroposterior view.

The intercondyloid fossa can be visualized on a roentgen film by a rather simple technic. As the roof of the intercondyloid

fossa is tilted for 60 degrees, thus we flex the knee joint for the same amount. For a more distinct detail, we do not use intensifying screens but a film wrapped in black paper, which is placed in good apposition in the popliteal space with the knee in a flexion of 60 degrees. It is advisable to use a lead sheet underneath the film in order to obliterate the back-scatter. The central ray is directed exactly below the inferior tip of the patella, and is perpendicular to the longitudinal axis of the tibia. A narrow

DISCRETE PULMONARY LESIONS, ROENTGENOLOGICALLY CONSIDERED

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It is an undisputed fact that the roentgen examination of the chest is a distinct aid in the diagnosis of pulmonary disease, particularly so in conditions which manifest themselves as discrete lesions, some of which are so small that they are frequently overlooked on ordinary physical examination. It is also true, however, that

Miliary tuberculosis—acute, chronic, and healed,
Miliary bronchopneumonia,
Emboic pneumonia,
Miliary malignancy,
Pneumoconiosis,
Secondary sarcoma and carcinoma,
Hodgkin's disease,

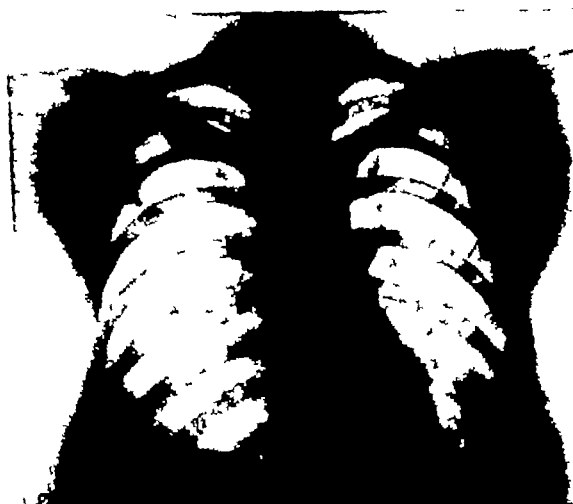


Fig. 1 Round foci type of pulmonary tuberculosis



Fig. 2 Exudative type of tuberculosis, calcified

the nature and differentiation of these shadows cannot always be recognized on the roentgenogram alone, yet if they are correlated with all the clinical and laboratory data, a proper interpretation of the pathologic condition may be made.

Discrete pulmonary lesions appear on the roentgenogram as variously sized, isolated, more or less circumscribed areas of increased density. Many of these disease processes have been described by Sante. These discrete shadows are manifestations of some of the following pathologic processes:

Round foci type of tuberculosis,
Exudative type of tuberculosis,

Leukemia,
Niemann-Pick disease,
Nodular gummatous syphilis,
Pulmonary cysts,
Lobular atelectasis

Recently, Albert, Fraenkel, and Straub have called attention to a type of pulmonary tuberculosis occurring as isolated, sharply defined, coin-sized, round, encapsulated shadows with no reaction of the surrounding tissue. They may develop with or without fever and with positive or negative sputum. These foci may remain stationary for years, even in the presence of a progressive or fatal tuberculosis elsewhere. They may eventually pro-

SUMMARY

The anteroposterior view of the knee joint may only give a limited knowledge of the underlying pathology, while the flexed position enables one to visualize the knee joint in greater detail. It is our plea that this view should always be used when vague intra-articular disturbances are present. The reasons are, first, that pathology, if present, is more sharply demonstrated, and second, that no elaborate apparatus is needed.

The visualization of calcified crucial ligaments, calcified interligamental bodies, and erosion of the surfaces of the intercondyloid borders of the femur may aid in the differential diagnosis of internal derangement about the knee joint.

This paper has been limited to the anatomy and roentgen technic of the intercondyloid fossa, with presentation of only a few cases. At a later date, we will attempt to give a more complete survey of the correlation of the symptoms and pathology of the intercondyloid fossa.

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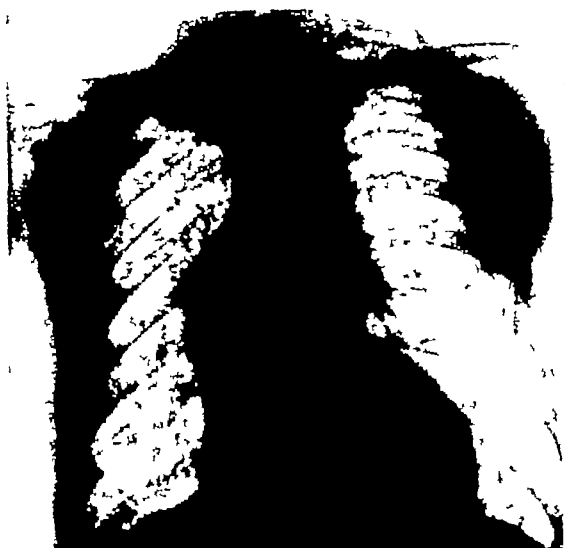


Fig 7 Pneumoconiosis second stage



Fig 8 Silicosis more advanced stage

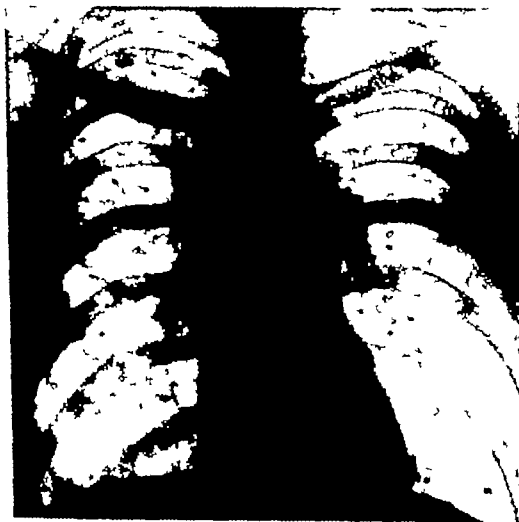


Fig 9 Healed miliary tuberculosis



Fig 10 Metastatic carcinoma Primary lesion in right breast

diagnosis. Repeated or serial roentgenograms for the purpose of studying the morphological changes are extremely important. I have recently seen a case of this type of pulmonary tuberculosis through the courtesy of Dr S. Bruck in a young woman whose pulmonary fields presented these round foci which had at first been diagnosed as tumor metastases (Fig 1).

The exudative type of pulmonary tuberculosis first manifests itself as a cluster of minute soft infiltrations at the periphery of

the lung in the apical or sub-apical region. No other condition with the exception of actinomyces which is very rare, produces a similar picture (Sante). These soft infiltrations may coalesce and form an irregularly shaped consolidation or may calcify producing clean-cut discrete shadows (Fig 2).

In miliary tuberculosis of the lungs we have a uniform pinhead-sized infiltration extending from the apex to the base, and with the exception of healed miliary tuber-



Fig 3 Miliary tuberculosis



Fig 4 Sub acute dissemination of pulmonary tuberculosis. Original lesion at the base of the right upper lobe

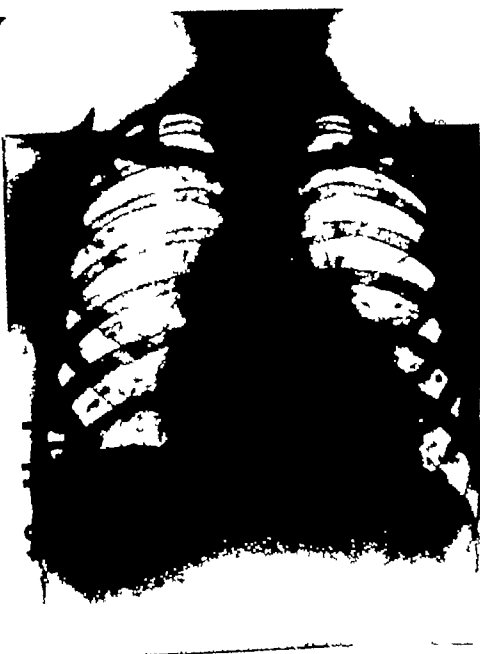
Fig 5 Diffuse nodular tuberculosis (autopsy)
First diagnosed as metastatic malignancy

Fig 6 Diffuse calcified metastasis (osteogenic sarcoma of right femur)

gress, however, and go on to liquefaction and cavitation, extending into the surrounding tissue by the formation of daughter foci. These lesions constitute a rare form of development of exudative focal tuberculous inflammation isolated by a connective tissue capsule.

Owing to the rarity of round foci of a

tuberculous nature, one has great difficulty in differentiating them from tumor metastases, which very commonly appear as round pulmonary shadows. They may also simulate non-tuberculous bronchopneumonia, syphiloma, cysticercosis, and echinococcus cysts. The clinical history plays a most important part in the differential



Fig 15 Congenital cysts Some of the cysts contain fluid some air



Fig 16 Lobular atelectasis due to a benign papilloma arising from the right lower bronchus

however, some variations in size, consistency, and distribution of the nodular shadows which will aid in differentiating them (Figs 3, 4, and 5)

In the miliary type of metastasis, a very rare condition, both lungs are studded with discrete opacities, however, the upper thirds usually show comparative freedom from these deposits. The infiltrations are larger and irregular, and, with the exception of the calcific-like metastases occurring in some forms of osteogenic sarcoma, never calcify. The history of a previously existing malignant growth will aid in differentiating this condition (Fig 6)

The second stage of pneumoconiosis presents a diffuse, fine mottling throughout both lungs due to very small fibrotic nodules. These nodules vary in size from a pinhead to a pea, and usually start first on the right side near the root of the lung, and later acquire a more uniform distribution. The history of occupational exposure to dust and the mild clinical evidence of a

process as extensive as the roentgenogram would indicate, should determine the differentiation between this condition and the diseases presenting a similar appearance (Figs 7 and 8)

Occasionally one encounters a roentgenogram showing a symmetrical distribution of minute calcified deposits. These shot-like deposits remain stationary in serial roentgenograms, and, according to Opie, may represent healed miliary tuberculosis (Fig 9)

Secondary carcinoma and sarcoma usually record themselves in the lung structure by the presence of round plaques of variable size with no inflammatory reaction of the surrounding tissue. These opacities are usually more numerous in the lower lobes and rarely, if ever, involve the apices. The infiltrations of sarcomatous nature may be circular, sharply outlined, and larger than the ordinary carcinomatous metastases, which are small and somewhat irregular (Sante). However, it is not always pos-



Fig 11 Metastatic sarcoma Primary lesion in right adrenal

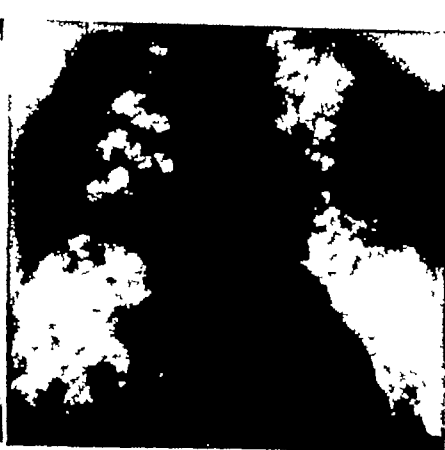


Fig 12 Metastatic malignancy (?) Clinical diagnosis, polycythemia vera No primary lesion found, no autopsy



Fig 13 Hodgkin's disease, pulmonary involvement, the nodules showing confluence



Fig 14 Pulmonary syphilis (gumma) ? Patient greatly improved under antisyphilitic treatment

culosis, the lesions are soft in consistency. In serial roentgenograms, they will be seen to increase in number and size, although they never attain the size of the nodules observed in bronchopneumonia and rarely coalesce. It is well to remember that in these patients there is little, if any, evidence of previous tuberculosis of the lung. This acute type very often simulates miliary bronchopneumonia and septic pneumonia, both clinically and roentgenologically, the symptoms being very severe in each instance. However, miliary bronchopneumonia and embolic pneumonia are rare and roentgenographically the foci in miliary bronchopneumonia appear larger

and acquire a peribronchial distribution, involving the lower two-thirds of the lungs. In embolic pneumonia the infiltrations are rather blotchy in appearance and poorly defined. They may be scattered throughout the lungs, but the lower lobes and the hilum regions are chiefly involved. The condition is usually a part of a generalized infection and a blood culture will, of course, aid in the diagnosis. Serial exposures will show, if the patient survives, resorption of the lesions.

Again, the picture of miliary tuberculosis, particularly the chronic form, is also suggestive of miliary carcinoma and pneumoconiosis in its second stage. There are,

syphilitic infection Sante claims that he has never observed an authentic case of lung syphilis, nor does he know of any proven case recorded However, the Wassermann test and the finding of the infection in other organs may help in the diagnosis (Fig 14)

Cystic lung disease is not of common occurrence It may be congenital or due to parasitic infestation, and may occur as a single lesion or present multiple cysts scattered throughout one or both lungs¹

Cysts of congenital origin are often an accidental finding, though they may present clinical symptoms They appear as small, round, sharply delineated shadows of homogeneous density without any surrounding lung reaction (unless they rupture or become infected), or as thin pocketed cavities suggesting localized pneumothoraces The persistence of these shadows without change and the paucity of the clinical symptoms are factors to be considered in the differential diagnosis (Fig 15)

Cysts due to parasitic infection include the echinococcus and cysticercus, the presence of which is very often marked by clinical manifestations The findings in the roentgenogram will depend on whether the cyst has ruptured or is closed In the former type the cystic lesion may be obscured by the inflammatory reaction, which closely resembles pulmonary abscess, in the latter, the shadows are fairly characteristic, being circular, sharply circumscribed, and of homogeneous content, with the exception of the opacities in cysticercosis, which may have a central pea-sized nucleus (Lachmann) To differentiate the closed type from metastatic tumor, the age of the patient as well as the prolonged course with relatively slight disturbance of general health may be of aid in establishing a diagnosis Serologic study will help rule out syphilis

lobular atelectasis is a secondary mani-

festation resulting from bronchiolar occlusion or stenosis The appearance on the film is that of small, irregular, dense areas, very often resembling lesions of other etiology The roentgenologic diagnosis may offer considerable difficulty, and a careful consideration of the clinical history and other methods of examination are necessary to supplement the information given by the x-ray (Fig 16) It is well to bear in mind that the small, irregular, patchy shadows noted on chest films of newborn are due to anectasia or failure of complete lung expansion, and that repeated roentgen study will reveal the nature of these opacities (Figs 17 and 17-A)

CONCLUSIONS

In conclusion, it may be briefly stated that—

1 The roentgenologic examination affords the best means of detecting these lesions

2 The discrete shadows cast by the many pathologic processes present roentgenologic appearances that closely resemble each other

3 A definite knowledge of the history, clinical manifestations, and laboratory studies are essential for a differential diagnosis

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¹ Dermoid cyst and teratoma are not considered in this presentation as they occur most frequently within the mediastinum and displace rather than invade the lung tissue



Fig 17 Atelectasia or failure of complete lung expansion in a newborn



Fig 17 A Same case as shown in Fig 17 Disappearance of the atelectatic areas with complete lung expansion

sible to differentiate between the two on the roentgenogram, nor is the differential diagnosis between metastatic malignancy and similar opacities produced by inflammatory and benign conditions simple from the roentgenologic findings alone. The clinical aspects of the case and the serial roentgen examination at intervals are frequently necessary for a clear differentiation (Figs 10, 11, and 12).

In rare cases of leukemia and Hodgkin's disease, multiple small shadows may be seen throughout the lungs resembling military bronchopneumonia and military tuberculosis. The associated mediastinal adenopathy, clinical and blood findings suggest the nature of the lesions. Saupe has recently drawn attention to the more common occurrence of this type of Hodgkin's disease, and states that the pulmonary foci may develop before involvement of the gland structure. In cases in which there is no associated mediastinal tumor the nature of these foci offers a difficult problem. It is well to remember that a test treatment may be of aid in the differential diagnosis, since

lymphomatous masses react very favorably to radiation (Fig 13).

The lungs in Niemann-Pick disease may rarely show small shadows resembling generalized bronchopneumonia. The presence of such infiltrations in infants having splenohepatomegaly should suggest the possibility that these may be local manifestations of a general disorder in lipid metabolism.

Discrete pulmonary manifestations in syphilis are not at all common. The tertiary stage may occasionally become roentgenologically demonstrable by the appearance of ill-defined and irregularly round foci. These shadows are usually found in the lower portion of the lungs in close relation to the hilum. They are often connected with fibrous strands extending into the adjacent lung structure and rarely liquefy to form cavities, more frequently they become converted into fibrous tissue. Calcification is absent. Syphilis of the lungs records a picture with no characteristics to stamp its true nature. Some observers believe that the lung structure is relatively, if not entirely, immune from

METHODS OF ENHANCING ROENTGEN-RAY ACTION

By A J DELARIO, M D , Roentgen Therapist, St Joseph's Hospital, Paterson, N J

THE problem in the treatment of malignant disease by means of radiation is at present directed along two lines (1) In which the malignant tissue is made more sensitive to the action of radiation, (2) in which radiation is made more lethal to the malignant cells

We have used electric currents of high frequency, 30 to 50 million cycles per second, with a wave length of from six to ten meters, in the treatment of Flexner-Jobling rat tumors¹ and, after having determined the action and the result of treatment with this modality, have combined it with roentgen therapy to determine whether the action of the roentgen ray is modified by the giving of high frequency before, during, or, after roentgen therapy We also have studied the action on these tumor cells of high frequency currents and roentgen rays, when metallic radiators were placed within the tumor tissue

VARYING TISSUE SENSITIVITY TO ROENTGEN RAY

A great deal of work has been done upon the methods of varying tissue sensitivity to roentgen ray by interference with the blood supply of various tissues (24, 25, 11, 12, 53) While the roentgen-ray reaction is diminished following the occlusion of blood vessels as demonstrated by the above workers active hyperemia induced by thermal changes, ultra-violet ray, irritating and toxic substances, increases the reaction to roentgen ray (23 26, 19 20 44, 7, 8, 31, 33, 42, 18, 32, 2)

If we could cause a selective action, affecting only the malignant cells, and but very little of the surrounding tissues then these various methods of making tissues more sensitive to the action of roentgen ray might be of some value If the malignancy

is in the skin, the various uses of infra-red, hot water bags, long wave diathermy, ultra-violet ray, and skin irritants might be of some value in causing greater reaction to roentgen ray However, when the tumor is below the surface, an effort must be made to get less skin reaction and more depth reaction in the tumor cells With this thought in mind, therefore, we investigated the effects of radiotherapy upon tumor growth, for we know that these short radio waves produce more heat at a depth than at the surface

FEVER AND TUMOR REGRESSION

There is a great deal of controversy upon the value of fever in the destruction of cancerous tissue The beneficial result obtained by means of Coley's toxins (toxin produced by erysipelas and prodigious bacteria) is said to be due to the fever which is produced by them (5) The greater the fever, the greater the number of cases of regression We have noticed several cases of highly malignant and fast-growing tumors disappear with an attack of erysipelas, and this is likely to be especially true in the case of old people

Rohdenburg (45), in a study of regression of human cancer, found that spontaneous cures have followed acute febrile attacks, or incomplete surgical removal of the tumor, and, occasionally, profound metabolic changes, such as extreme cachexia, artificial menopause, or puerperium Cases of regression of human cancer have occurred after attacks of malaria, typhoid fever, and tuberculosis (6)

Exactly how fever works is not known, whether fever is a mere expression of a more basic physico-chemical change going on in the cells, or whether the fever itself is the important factor is still in the process of investigation Artificial fever produced by high frequency electric currents has been studied in many diseases Its study in

¹ We are greatly indebted to Kanematsu Sugiura, M D of Memorial Hospital New York City from whom we obtained the Flexner Jobling tumor

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three minutes, this prevented growth when the transplants were made. Also, if the tumors were placed between two hollow copper electrodes through which water heated to 48 to 49 degrees C circulated, the tumor disappeared.

Reiter (43) found that the most effective wave length in the treatment of Flexner-Jobling tumors was between three and four meters, *i e*, a frequency of 75 to 100 million cycles per second. His study included waves between three to seventeen meters. He found that between three and four meters the change produced by the dielectric loss is a dilatation of the blood vessels, edema, and necrosis, *i e*, the changes are essentially inflammatory. The rats were exposed for five two-minute periods at intervals of one minute. Eighty per cent of the tumors disappeared by this method.

He thought that the temperature effects could be excluded, and that the main effect was a marked suppression of the anaerobic fermentation of sugar, rising as high as from 80 to 90 per cent with a wave length of 3.4. Human material showed this effect with a wave length of 3.65 meters. He found that the roentgen ray showed no effect on the anaerobic fermentation with as high as 5,000 r units, above this the effects were the same as short radio wave.

Fuke (13, 14) found that the Flexner-Jobling carcinoma disappeared with a 30-minute treatment by means of diathermy heat, with 250 milliamperes. Sometimes a second application was necessary. When he used 300 milliamperes the animal died. This, he thought, was due to a reduction in the blood sugar, as well as local inflammatory changes in the tumor. Reduction of blood sugar was due to accelerated glycolysis.

Ludwig and Von Ries (30) found that high frequency given to both plant seedlings and mouse carcinoma, in daily treatments of three seconds each inhibited but did not totally destroy growth.

According to Knopfmacher (29), high frequency restores the power of the patient's serum to digest cancer cells. Freund's theory is that the serum of the cancer pa-

tient will not destroy cancer cells, whereas normal serum will.

Some investigators believe that heat has no effect whatever on the tumors.

Woglum (51), causing fever in rats and mice as high as 42 C, for a total number of 31 to 340 hours, found no effects upon the tumors. So also did Kamekura (27), who kept tumor-bearing mice for 20-minute periods two to three times weekly in incubators at 42 degrees C (107.6° F), obtaining negative results. However, Schereschewsky (47) states that his results were obtained with tumor temperature of 48 degrees C, the temperature of the animal itself remaining near normal. There may, of course, be some properties of the high frequency current independent of heat.

Mellon, Szymanowski, and Hicks (39) found that, using a frequency of 158,000,000 cycles per second, the activity of the diphtheria toxin was reduced with temperatures as low as 15 degrees C.

McKinley (34) found that, on exposing the whole vertebral column of the frog to 90 million cycles per second, an immediate violent muscular contraction of the hind legs occurred. With the application of external heat to the vertebral column this did not take place. Nor are all tissues in the same organism affected equally. Schliephake (48) found the heating rate of brain tissue to be high. Headlee and Burdette (21) found cholesterol, present in great abundance in nervous tissue, to have the highest heating rate, when compared to many other organic compounds.

Even in the inorganic field, according to McLennan and Burton (38), the heating effect depends upon the kind of substance in solution and its concentration. In solutions of lower concentration the maximum heating effect is observed when lower frequencies are used, and at higher concentrations the maximum heating effect is observed with higher frequencies.

According to McKinley (35, 36, 37), the high frequency action may be different at different phases in the development of an organism. In working with insects in which the nervous system was more highly

syphilis has been undertaken by many investigators (46, 4, 28, 41) Bishop, Horton, and Warren (3) report its use in gonococcus conditions, local and generalized, multiple sclerosis, and encephalitis, acute and chronic Tenney (50) studied its action in arthritis, bursitis, myositis, and neuritis, and its application in Raynaud's disease, thrombo-angitis, and arterial sclerosis

From these numerous studies it has been found that as a result of heat there is at first a systolic rise and a diastolic drop in the blood pressure, later on in the series of treatments, both systolic and diastolic pressure drop and stay down There is an increase in heart rate and a dilatation of blood vessels Concentration phenomena occur, such as a rise in red and white blood cells and in hemoglobin, an increase in non-protein nitrogen, in blood uric acid, blood chlorides and calcium, and a decrease in the CO₂ capacity of the plasma (41) Hinsie and Blalock (22) describe the increase in leukocytes Tenney (50) states that there is an increase in blood platelets and an increase in the number and size of the capillaries of the nail-bed, the skin wheal due to histamine is larger after heat therapy than before The viscosity of the blood increases unless plenty of fluids are given during treatment

In tumors, this dilatation of blood vessels, increase in viscosity, and accompanying thrombosis may have something to do with the beginning of tumor regression, the increase in white blood cells, and especially the lymphocytes, which also contribute to the regression (10, 40)

DeCourcy (6) believes spontaneous regression of cancer is due to dilatation of blood vessels, hemorrhage, thrombosis, necrosis, and lymphatic infiltration in the tumor Immunological reaction produced by protein absorption from this mass completes the regression of the local tumor and distal metastases This disturbance in the circulation of some mouse and rat tumors by the injection of bacterial toxins producing the Swartzman reaction is said to be the cause of the tumor regressing (9) It is probably also the cause of regression of

tumors in cases in which only an incomplete surgical removal is done, or the taking of a biopsy, and in such cases as those in which rattlesnake venom is given

As a result of the numerous instances in which fever was found to be associated with the regression of tumors, a great deal of experimental work has been done, and is still being done, with conflicting reports, on the application of heat, especially that produced by high frequency currents, on the regression of plant, experimental animal, and human tumors

Gosset, Gutmann, Lakhovsky, and Magrou (17), who were the first to work on the effects of high frequency electro-magnetic radiation produced by a vacuum tube oscillator, in 1924, found that in three geranium plants bearing tumors produced by *Bacterium tumefaciens*, the tumors disappeared at the frequency of 150,000,000 cycles per second (wave length of 2 meters) One plant was given two exposures of three hours each on consecutive days, one plant was given three, and one plant, eleven such exposures After sixteen days from the first exposure, the tumors, after growing in the interval, began suddenly to necrose In fifteen days the tumors could be detached by slight traction

Working only with heat as produced by an electrical frequency, Schereschewsky (47), by the application of varnish-covered copper electrodes through which a frequency of 90 to 100 million cycles per second (wave length, 3 to 3.3 meters) was passed directly to the tumors, with two- to three-minute exposures and a milliamperage of 200 to 300, got 60 to 75 per cent tumor regression in mice when the tumors were below 15 to 20 mm in diameter The mouse sarcoma, C R 180, was used The same percentage of recoveries occurred in the rat sarcoma in tumors below 30 to 50 mm in length He obtained recoveries in Rous fowl sarcoma The temperature of the tumor went up to 48 to 49.6 degrees C in from 1.5 to 2 minutes He believes that the effect is solely due to heat, for when the tumors to be grafted were placed in Locke's solution at 48 to 49 degrees for

In order to obtain the above factors at the condenser plates, we had several tube machines made under our direction by

treated, the tumors grew more slowly, ulcerated later, and grew to a bigger size before ulceration. In order that we might not

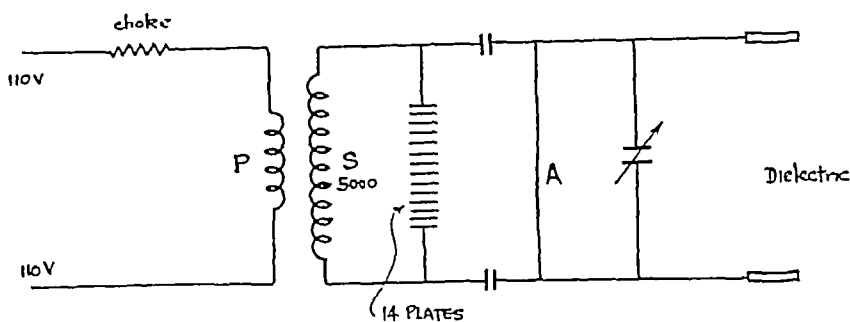


Diagram 2 Lepel's Radiothermy

Marsh and Maxham, engineers of Montvale, N J, and toward the latter part of the work, in order that a stronger voltage, wattage, and milliamperage might be tried, we used a Lepel short wave thermy, which wave length ranged between 6 and 9, voltage 5,000, milhamperes, 2,000 plus, and wattage, 140. Our first machines were thermionic oscillators, whereas Lepel's is a spark discharge oscillator. Diagrams 1 and 2 give the outline of the radiothermy set-up.

The animals received from one to 25 treatments, averaging eight, the treatments were given daily, and the temperatures ranged from 97 to 108.6° F. The temperature usually rose to 103 degrees about one-half hour after the beginning of treatment, which lasted from one to two hours. Occasionally, the temperature continued to rise until the end of the treatment but more frequently it would start to fall about the end of the first hour. In the majority of cases by the end of the first hour after treatment was completed, the temperature had returned to normal. The animals underwent a great deal of shock while in the treatment box, they became hot and had nosebleeds. The ears became red and the testicles reached two to three times their usual size. The animals sweated a great deal and became very restless. However as soon as the treatment was completed, they would eat, and soon appeared normal.

Our opinion is that in the animals

be misled by the possibility that the tumor would disappear anyway without treatment, we usually took the largest tumors for the experimental animals, and used the animals with the smaller tumors for the controls. We rarely started treatment unless the tumor was 1 cm in diameter, sometimes waiting three weeks before doing so. If we disregard all tumors except those which had reached the dimensions of 1 cm in diameter, then only 9 per cent of the tumors which were not treated disappeared, whereas 21.7 per cent of the tumors which were treated disappeared (See Table I). We had several large ulcerating tumors, one tumor being 2 by 2.5 cm, and the other 1.2 by 1.2 cm, which healed after treatment.

It seems to us that the increase in temperature, with the sweating accompanying it, made the tumor smaller, probably from dehydration. The ulcers appeared dryer, and quite often would form scabs. Probably this water absorption was a factor which prevented rapid growth. As we know, the greater the water concentration in the tumor, the faster the rate of growth. While we admit that there is a slight advantage, we doubt very much that this method of treatment in itself, and alone, is worth while, and surely it is not practical, and cannot approach the efficacy of the other methods of treating cancer. However, when the radiothermy is applied locally to the tumor, more heat can be

organized in the adult than in the larval form, the time of the lethal exposure was six times longer in the larval form. Where

upon which there remained some controversy, namely, the effects of radiotherapy alone, on tumor growth. We had a spe-

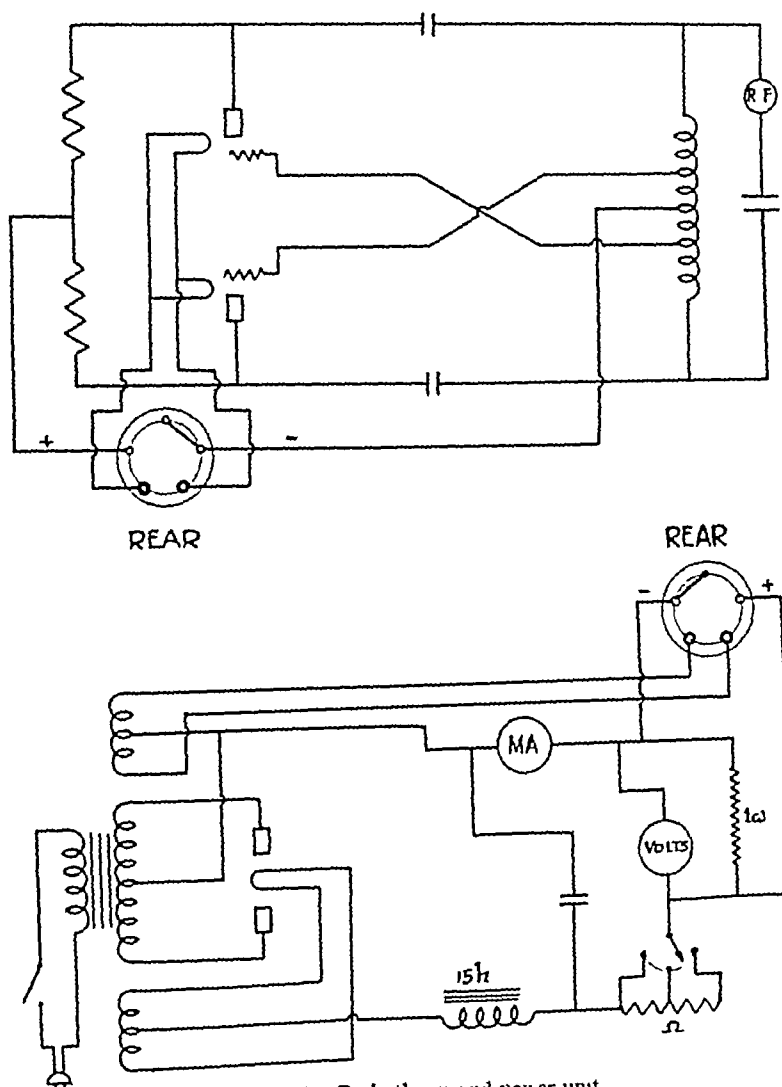


Diagram 1 Radiotherm and power unit

little difference existed in the nervous system between adult and nymph, the lethal dose was the same.

THE RESULTS OF THE EXPERIMENTS ON THE APPLICATION OF RADIO THERMY TO THE FLEXYNER-JOBLING RAT CARCINOMA

In order to study the effect of radiotherapy upon the action of the roentgen ray, and to obtain a standard of comparison, it was necessary for us to repeat work

cially made box, large enough to allow the rat to move about, and yet small enough to allow a good concentration of current. The box was connected with the radiothermy circuit. The voltage at the condenser plates at the side of the box ranged from 400 to 700. The milliamperes ranged from 200 to 700, and the wattage output was about 40. Our frequencies varied from 30 to 60 million cycles per second, and the wave length from 6 to 10 meters.

In order to obtain the above factors at the condenser plates, we had several tube machines made under our direction by

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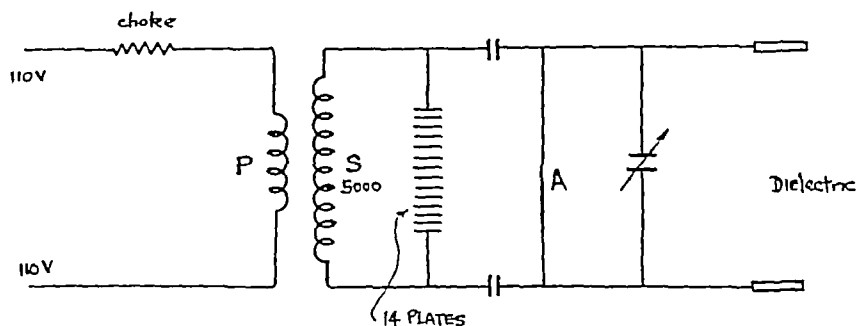


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given without killing the animal, and the results are better, according to Scherschewsky, *et al* (47)

THE RESULTS OF THE EXPERIMENT ON THE APPLICATION OF ROENTGEN THERAPY TO THE FLEXNER-JOBLING RAT CARCINOMA

Before we could evaluate the action of radiotherapy and roentgen ray given simultaneously to the Flexner-Jobling rat tumor, it was also necessary to determine the action of roentgen therapy alone on this tumor. We made provisions to apply roentgen ray to the whole animal through the top of the radiotherapy box. The animals usually received about 400 r to the tumors. This amounted to one-half or one skin erythema dose, depending upon whether or not filters were used.

We tried the effects of roentgen ray with no filters. Also, we used 0.25 mm copper and 3 mm aluminum, we used 0.8 mm copper and 3 mm aluminum on other cases. We used 100 kilovolts with no filter, 150 kilovolts with 0.25 mm copper and 3 mm aluminum, and 180 kilovolts with 0.8

mm copper and 3 mm aluminum. We used 5 milliamperes, distance 30 cm from target to tumor.

Sugiura and Benedict (49), working with this Flexner-Jobling tumor and the amount of gamma rays measured in skin erythema doses, found that no tumor regressed with less than 1.5 skin erythema dose, and that one-half of the tumors regressed with two to three skin erythema doses. With more than three skin erythema doses, regression occurred in 90 per cent of the cases in which tumors were not more than 2 cm in diameter. Tumors from 2.4 to 3.3 cm in diameter were seldom destroyed with doses as large as six skin erythema doses.

Since our tumors were usually treated when they were about 1.5 cm in diameter, and since they never received more than one roentgen-ray skin erythema dose, our percentage of cures was not as high as that obtained by Sugiura.

Of course, there was some question as to whether the giving of roentgen ray to the whole organism instead of to the tumor alone might not produce some general or

TABLE I—RESULTS OF INVESTIGATION OF EFFECTS OF FEVER PRODUCED BY SHORT RADIOTHERAPY ON THE FLEXNER-JOBLING RAT CARCINOMA

Number of series	14	
Number of animals transplanted	137	
Number of positive transplants	81	
Percentage of positive transplants ranged from 13 to 100; average was	58.4	
	Controls (44)	Experimental animals (37)
<i>Tumors cured</i>		
Number of tumors cured entirely and percentage*	17 (38.6%)	13 (35%)
Number of tumors disappearing but animal died before cure	0	0
Number of tumors above 1 cm cured entirely and percentage	4 (9%)	8 (21.7%)
Largest tumor cured	$1\frac{1}{4} \times 1\frac{1}{4}$ cm	$2\frac{1}{4} \times 2\frac{1}{2}$ cm
Age of largest tumor cured	8 wks	18 wks
Smallest tumor cured	$\frac{1}{8} \times \frac{1}{8}$ cm	$\frac{1}{4} \times \frac{1}{4}$ cm
Average size of tumors cured	$\frac{3}{8} \times \frac{1}{8}$ cm	$1 \times 1\frac{1}{8}$ cm
Average age of tumors cured	4.4 wks	7.6 wks
<i>Tumors ulcerating</i> [†]	27	24
Size reached before ulceration occurred		
Greatest size	4×4 cm	$4\frac{1}{2} \times 5$ cm
Smallest size	$\frac{3}{4} \times \frac{3}{4}$ cm	$1\frac{1}{2} \times 1\frac{1}{2}$ cm
Average size	$1\frac{1}{2} \times 1\frac{3}{4}$ cm	$2\frac{1}{2} \times 2\frac{1}{2}$ cm
Age of tumor before ulceration occurred		
Greatest age	10 wks	9 $\frac{1}{2}$ wks
Shortest age	2 $\frac{1}{2}$ wks	3 $\frac{1}{2}$ wks
Average age	4 wks	5 wks
Number of tumors healing after ulceration	0	2 ($2 \times 2\frac{1}{2}$, $1\frac{1}{4} \times 1\frac{1}{4}$)

* Experiments were started on tumors at the age of two weeks. According to Sugiura (49), 20 per cent of tumors disappear after the age of two weeks without treatment.

† This depends a great deal on depth of transplantation. We tried to keep ours uniform.

immunological reaction to cause the disappearance of the local tumor. Although the number of tumors which disappeared with roentgen ray did not seem to be any greater than the number that disappeared without any type of treatment, it must be remembered that if tumors above one centimeter only are considered, then the number that disappeared with roentgen ray alone was 16.6 per cent, with diathermy alone, 21.6 per cent, and with diathermy and roentgen ray together, 38.4 per cent (See Table II).

The giving of roentgen ray alone did not raise the temperature of the animals, except in an occasional case, and then the temperature was never more than one or two degrees above the temperature before treatment. Occasionally the giving of roentgen ray was accompanied by a decrease in temperature of one or two degrees, especially if the temperature at the beginning of treatment was one or two degrees above normal.

THE ACTION OF ROENTGEN RAY AND RADIOTHERMY GIVEN SIMULTANEOUSLY

When the above roentgen-ray treatment was given before or after the usual radiotherapy treatment, there did not appear to be any unusual changes in the general condition of the animals or in the number of tumor regressions other than those observed when radiotherapy alone was given.

However, when roentgen-ray therapy was given simultaneously with radiotherapy, very unusual reactions occurred. The first thing noticed was that the animals' temperatures went up on the average of two or three degrees higher than they did with radiotherapy alone, and whereas the animals could always be kept under radiotherapy two or more hours at a time, when roentgen therapy was given at the same time the animals began to fight and run mad in the box ten or fifteen minutes after the starting of the treatment. Of those that were given the full twenty minutes of roentgen-ray treatment, 23.05 per cent

TABLE II - RESULTS OF THE TREATMENT OF FLENNER-JOBLING RAT CARCINOMA WITH RADIOTHERMY AND ROENTGEN RAY COMBINED

Number of series	12
Number of animals transplanted	129
Number of positive transplants	78
Percentage of positive transplants ranged from 0 to 100 - average	60.4

	<i>Controls</i> (X ray alone) (30)	<i>Experimental animals</i> (39)
<i>Tumors cured</i>		
Number of tumors cured entirely and percentage	9 (25%)	18 (46.1%)
Number of tumors disappearing but animal died before cure	3 (8.3%)	9 (23.05%)
Number of tumors above 1 cm. cured entirely	6 (16.6%)	15 (38.4%)
Largest tumor cured	2 X 2 cm	1 1/2 X 2 cm
Age of largest tumor cured	9 wks	5 1/2 wks
Smallest tumor cured	1 1/2 X 1 1/2 cm	1/2 X 1/2 cm
Age of smallest tumor cured	1 1/2 wks	2 wks
Average size of tumors cured	1 1/2 X 1 1/2 cm	1 1/2 X 1 1/2 cm
Average age of tumors cured	4.7 wks	4.5 wks
<i>Tumors ulcerating</i>		
Number	24	12
Size reached before ulceration		
Greatest size	3 1/2 X 3 1/2 cm	4 X 5 cm
Smallest size	2 X 2 cm	2 X 2 1/2 cm
Average size	2 X 3 cm	3 X 3 1/2 cm
Age of tumor before ulceration		
Greatest age	6 wks	7 wks
Shortest age	3 wks	5 wks
Average age	4.5 wks	4.5 wks
Number of tumors healing after ulceration occurred	0	0

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THE RESULTS OF THE EXPERIMENT ON THE APPLICATION OF ROENTGEN THERAPY TO THE FLEAHER-JOBLING RAT CARCINOMA

Before we could evaluate the action of radiotherapy and roentgen ray given simultaneously to the FleaHER-Jobling rat tumor, it was also necessary to determine the action of roentgen therapy alone on this tumor. We made provisions to apply roentgen ray to the whole animal through the top of the radiotherapy box. The animals usually received about 400 r to the tumors. This amounted to one-half or one skin erythema dose, depending upon whether or not filters were used.

We tried the effects of roentgen ray with no filters. Also, we used 0.25 mm copper and 3 mm aluminum, we used 0.8 mm copper and 3 mm aluminum on other cases. We used 100 kilovolts with no filter, 150 kilovolts with 0.25 mm copper and 3 mm aluminum, and 180 kilovolts with 0.8

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push or pull This film test shows that roentgen-ray action is enhanced in a radiothermic field

The second experiment, in which we had copper and tin electrodes connected with a milliammeter and the ends immersed in saline solution, we used for the following reasons We know that the heat caused in an animal by means of a condenser is equal to the displacement current caused in the animal, times the resistance of the animal ($\text{Wattage} = I^2R$) We were anxious to find out whether roentgen ray added to radiotherapy caused an increase in the amount of displacement current, and in this way produced a greater amount of heat The amount of current caused by two dissimilar electrodes immersed in saline was registered on the milliammeter The milliammeter had chokes on each side so that it would not be affected by the radiotherapy and was covered by lead so that it would not be affected by the roentgen ray The amount of current in the milliammeter was recorded when roentgen ray and radiotherapy were given separately and when given together There was an increase of a few milliamperes above the normal when radiotherapy was given alone, about the same amount when roentgen ray was given alone When radiotherapy and roentgen ray were given simultaneously, there was sometimes as much as a 50 per cent increase over that of either radiotherapy or roentgen ray alone The temperature of the solution was kept the same, so that the increase in resistance to the current due to heat would not have to be considered

This experiment shows that roentgen ray by means of ionization, increases the displacement current in the animals caused by the condensers In this way one can explain the cause of greater temperatures when roentgen ray is added to radiothermic action

In the third series of experiments, in which an ionization chamber was placed in the box, we found that radiotherapy alone given for one half hour or more caused no loss in the charge in the ionization chamber The experiments when roentgen ray

alone was given, and when radiotherapy and roentgen ray together were given, have not been very satisfactory We usually get one or two more r per minute when radiotherapy and roentgen ray are given together than when roentgen ray is given alone Occasionally we have been able to get as much as twice the amount of r units per minute when roentgen ray is given with radiotherapy than when roentgen ray is given alone, but we have not been able to do this consistently Therefore, this experiment has not helped us very much in determining the mode of action of radiotherapy in a roentgen-ray field

METHODS OF INCREASING RADIOTHERMIC AND ROENTGEN-RAY ACTION ON FLEXNER-JOBLING RAT CARCINOMA BY MEANS OF METALLIC RADIATORS

Radiotherapy —When small steel needles are placed in the periphery or growing edge of a tumor, and the animal is then placed in the radiotherapy box, these steel needles heat up much faster and hotter than the tissue, the result being that there is formed a zone of dying tissue about the needles, about two millimeters in thickness However, if this needle is placed within the necrotic center of the tumor, no reaction is caused Further from the zone of necrosis areas of hemorrhage are seen In other words, here is a method of artificially producing the same biologic effect as radium The tumor at first swells, looks edematous, and seems to grow faster than the control on the other side of the animal, but this is only apparent, because in several weeks the control reaches a much greater size Sometimes the tumor with the needles ulcerates because of the edema and swelling, but this soon dries to a hard scab, and later the tumor disappears while the control grows to ulcerate and kill the animal Many animals, however, have died of the cancer, which can probably be explained by the inability to accurately place the needles so that all parts of the growing tumor cells have been reached We have not, however, used a sufficient number of animals to warrant a conclusion as to the value of this treatment

died. Some died before the treatment was ended, and the others, one, two, or three days later.

The temperatures usually started to come down in the second hour of treatment when radiothermy alone was given, with the combination of radiothermy and roentgen ray, the temperature continued to rise and the number of animals that died from the treatment increased. Although the mortality is greater, the number of tumors that disappeared with radiothermy and roentgen ray given together is greater than with any other treatment we have used, amounting to 46.1 per cent of the animals treated.

The question arises, Does roentgen ray enhance radiothermic action in causing this greater rise in temperature, thus causing more tumors to disappear, or does radiothermy enhance roentgen-ray action by causing greater ionization, and in this way causing greater biological reaction and tumor regression? Or is there merely a summation effect? This opened up a new field for our study on the action of roentgen ray in the radiothermic field, and the action of radiothermy in the roentgen-ray field. We thought that if these various factors could be determined physically, the biologic actions of both radiothermy and roentgen ray might be better understood.

The first experiment undertaken was to determine if there was a greater deposit of silver on a photographic film when radiothermy and roentgen ray were given together than the sum of both given at two different times. Secondly, by using saline solution, in which were immersed a copper and a tin electrode connected to a milliammeter, to determine if there were a greater flow through the circuit when radiothermy and roentgen ray were given together than the sum of the two given separately. Thirdly, by means of an ionization chamber, to determine if the number of r per minute was greater when roentgen ray and radiothermy were given together than when roentgen ray was given alone.

Film Test—It is known that a latent image will be formed by heat on a photo-

graphic film. It is also known that radiothermy causes heat. The alternating charging of the condenser plates causes a dielectric stress in the air between them, and in doing so some energy is lost. While condensers will give back to the circuit almost all the energy put into them, some energy is lost. The amount lost depends upon the capacity of the condensers, the greater the capacity the less the loss, depends upon the frequency with which they are charged and discharged, the greater the frequency the less the loss, also, it depends upon the substances between the plates, i.e., the type of dielectric. There is a greater loss with solid dielectric. In other words, when large animals are placed in the box, the more solid the dielectric becomes, the harder it will be for the condenser plates to cause a stress upon the animal molecules and, therefore, the more energy expended, and the more heat formed. This is what is known as heat formed because of dielectric loss. However, with the photographic film, the dielectric loss is so small, so little heat is formed, that it is apparently insufficient to cause a latent image, as is shown by the following test.

If a small piece of process film is cut in two, and one part only is placed in the radiothermy box for twenty minutes, both parts being kept in total darkness, and the two parts are then developed together for five minutes, there will be no deposit of silver on either film. If radiothermy is given to a similar piece of film for twenty minutes, and then roentgen ray is given afterward for one minute, the amount of silver deposited after the film is developed is appreciably less than when radiothermy and roentgen ray are given together for one minute only. Thus it seems that radiothermy by its dielectric ionic stress, or by its trying to pull the electrons more to the periphery of the atom, or if they are loose to pull them away from the atom, merely helps the roentgen ray to ionize these atoms, and if by chance there are some electrons which roentgen ray alone could just bring to the parting point, this radiothermic stress is enough to give the final

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Röntgen Ray—The use of metals as secondary radiators of roentgen ray has been tried before (1, 16, 15) Wood (52), found that colloidal lead, more than any other colloidal heavy metal, when combined with radiation, had a beneficial effect upon experimental tumors. It would be interesting to note what effect diathermy had on experimental animals in which was injected colloidal lead, either locally or intravenously.

By means of steel needles placed within the growing periphery of the tumor we have been able to give roentgen ray of a short wave length, therefore causing less damage to the skin and obtaining a greater depth dose than would have been possible with a longer wave length. The steel radiators change the short waves to long waves, thus causing more damage to the tumor tissue itself. This type of treatment also caused edema in the beginning, and slight ulceration, but the tumor grew much slower than the control on the other side. Likewise, in these animals that were given roentgen ray, there appeared a zone of necrosis about the needles.

Again, the number of experiments we have done has been too few, and we cannot give a definite report at this time as to its value.

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frequent sites are the lower end of the femur, the upper end of the tibia, and the lower end of the radius, giant-cell tumor has been seen in the ilium. Clinically, there was a history of trauma followed by pain and the development of a tumor. On the other hand, myeloma occurs most frequently during the sixth decade of life, involving, as a rule, the ribs, spine, pelvis, and upper ends of the femora. The multiplicity of the lesions is a most striking feature. This observation teaches us again not to place the diagnosis entirely on *one* single method of examination.

SYPHILITIC GUMMA OF THE LUNG (CASE REPORT)

B. PALMER E. WIGBY, M.D. and C. B. SANDERS
M.D. Dallas, Texas

From the Departments of Roentgenology and Pathology, Respectively, Parkland Hospital Dallas, Texas

Any manifestation of the acquired form of syphilis of the lung is a comparatively rare pathologic entity. The case herein reported, however, seems to justify the diagnosis.

In reviewing the literature of recent years, we found no case in which the roentgen examination disclosed the well circumscribed appearance without associated inflammatory changes that this case presented. This was probably due to the fact that their films of the chest were made later in the course of the disease than were ours, and, therefore, at a time when secondary inflammatory changes had altered the x-ray appearance. We were unfortunate in not being able to repeat the roentgen examination during the last three months of life. The extensive secondary inflammatory changes which can accompany such a lesion were evidenced by the postmortem report of this case.

Figures 1 and 2 show the x-ray appearance of the lesion three months before death.

Some pathologists hold that a lesion of tertiary syphilis manifesting itself in the lung usually cannot be considered syphilitic in origin unless it shows definite regression under anti-syphilitic therapy. Cases have been reported (1 and 2) which tend to refute this contention. We had no opportunity for making x-ray or any other examination after anti-syphilitic therapy, inasmuch as this patient did not return to the clinic after discharge from the hospital. We do not feel, however, that this fact casts any doubt upon the diagnosis in this case.

Another interesting and unusual feature of this case was the fact that there was no other evidence of visceral syphilis aside from the pulmonary findings.

Case 1. V. C., a colored man, hospital No. 091, aged 44 years unemployed but previously a chief was admitted to the service of Dr.

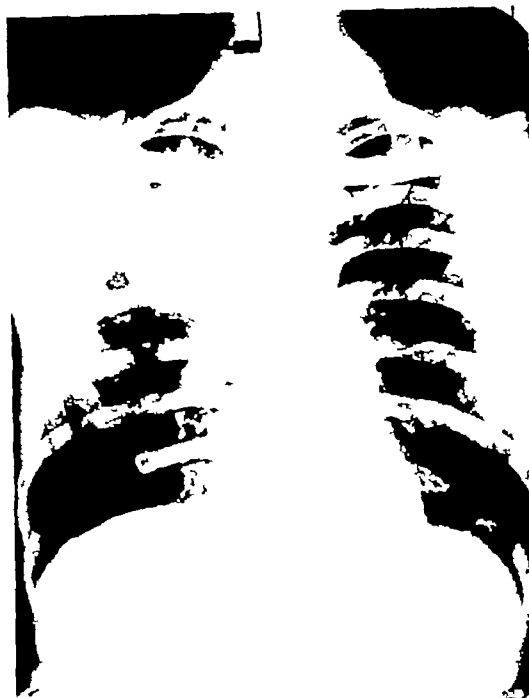


Fig 1 Frontal view of the chest three months before the patient's death

Robert Barton on Jan. 4, 1935, and discharged on Jan. 13, 1935. He died at home on March 29, 1935. On admission, the patient had the following complaints: dyspnea and productive cough with rusty sputum of eight months' duration, and a loss of 40 pounds in weight during that time. More recently there had been vague chest pains, and ten days previous to admission a gross hemoptysis.

Past History.—In 1917, while in the army, the patient developed a persistent non-productive cough which lasted for three months. Following this, he was in good health until 1926, when he developed the same symptoms as in 1917, which lasted this time about two months. The patient was again symptom-free until in April, 1934, which marked the onset of the symptom-complex complained of on admission, and which had caused semi-invalidism since that time. There was a history of primary penile lesion 18 years previous, at which time the treatment consisted of "six shots in the arm" at weekly intervals. He also had gonorrhea at that time.

Physical Examination.—The patient was well developed but somewhat under weight. There was no apparent distress except for slight dyspnea and an occasional productive cough. His temperature was 98.4 degrees, pulse 93, blood pressure 124/78, and respirations 20 per minute. His pupils were equal and reacted to light and accommodation. His

CASE REPORTS

PLASMA-CELL MYELOMA OF THE RIGHT ILIUM ROENTGENOLOGICALLY MISTAKEN FOR GIANT-CELL TUMOR

By E. A. POHLE, M.D., Ph.D. and W. D. STOVALL, M.D.
Madison, Wisconsin

From the Department of Radiology and Physical Therapy and the State Laboratory of Hygiene, University of Wisconsin

This case is reported because of its unusual diagnostic features. The patient, a woman aged 49 years, was referred to the Orthopedic

findings, and gynecological examination were negative (no Bence-Jones in urine). She was unable to walk or stand without the aid of crutches. There was loss of normal contour along the right iliac crest because of a tumor mass extending along the lateral aspect. The tumor was fixed to the underlying pelvis. The skin showed brownish pigmentation, apparently due to previous hot applications.

The roentgenograms of the pelvis showed a multiloculated lesion in the right ilium, which, in our opinion, had the appearance of a giant-cell tumor (Fig 1). The films were reviewed



Fig 1

Fig 1. Roentgenogram of pelvis taken on May 17, 1935.

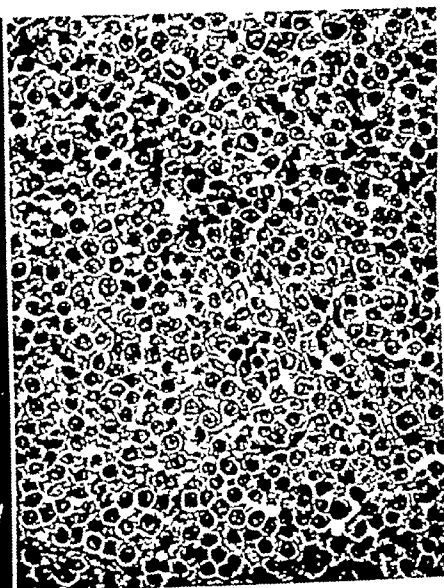


Fig 2

Fig 2. The sections show a compactly cellular tumor without stroma. The cells are small and uniform in size and staining reaction. The nucleus is placed excentric and contains blocks of chromatin arranged along the nuclear membrane. Mitosis is not seen. The cytoplasm is stained pink. Diagnosis as follows: myeloma plasma cell in type (Zeiss apochr. 20 Homal I, $\times 500$).

Service of the Wisconsin General Hospital on May 16, 1935, because of pain in the right hip. She had slipped and fallen on the hip in September, 1934, but was able to get up and walk with moderate pain. Hot pads were used which gave some relief. Two months elapsed without much change in her condition. She consulted first a chiropractor who treated her, and then saw an osteopath in March, 1935, who "set" the hip. No cast was applied. Walking remained more or less impaired and painful. Since no improvement in her condition occurred she finally consulted a physician who referred her to the Wisconsin General Hospital.

Her general physical examination, laboratory

by several other roentgenologists who concurred in this diagnosis. Roentgen therapy was planned accordingly. No other parts of the skeleton showed any demonstrable lesions.

A few days later the patient consented to have a biopsy done. At the operation the shell of the bone appeared to be very soft and yielded under finger pressure. Exploration showed that it could be cut with a knife and the interior curetted as a gelatinous bloody mass. Microscopic examination of the sections revealed a typical plasma-cell myeloma (Fig 2).

In reviewing our previous roentgen diagnosis we still feel that the appearance of the lesion is that of a giant-cell tumor. While the most

frequent sites are the lower end of the femur, the upper end of the tibia, and the lower end of the radius, giant-cell tumor has been seen in the ilium. Clinically, there was a history of trauma followed by pain and the development of a tumor. On the other hand, myeloma occurs most frequently during the sixth decade of life, involving, as a rule, the ribs, spine, pelvis, and upper ends of the femora. The multiplicity of the lesions is a most striking feature. This observation teaches us again not to place the diagnosis entirely on *one* single method of examination.

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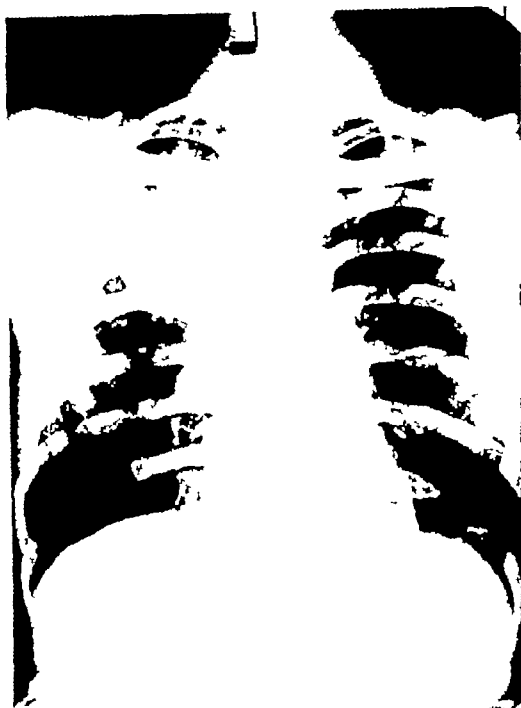


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Fig 2 Lateral views of the chest three months before the patient's death

chest showed equal and symmetrical expansion. A few râles were heard over the right lung posteriorly, with an area of dullness in the center and extending upward and medially where slight diminution in breath sounds was noted. There were râles over the apex anteriorly. With the exception of an old scar on the prepuce, there were no further pathologic findings on physical examination.

Laboratory Data—Urinalysis was negative. The blood count was 3,860,000 red cells, 6,100 white cells, 75 per cent hemoglobin (Sahli), and a normal differential. Repeated sputum examinations failed to reveal the tubercle bacillus. Blood Wassermann reaction was 4 plus.

Roentgen Examination of the Chest—A dense circular shadow, $6 \times 7.5 \times 6.5$ cm in size was noted in the medial portion of the right upper lobe, apparently arising from the upper pole of the right hilum. There was moderate surrounding bronchovascular infiltration, and atelectasis in the periphery of the first anterior interspace. A roentgenologic impression of neoplasm was given. A bronchoscopic examination by Dr. Abell D. Hardin, on Jan. 8, 1935, revealed bleeding from the mucosa of the trachea near its bifurcation and from the right upper main stem bronchus. All structures were edematous, and there appeared to be extrinsic pressure upon the lumen of the right

main stem bronchus. The appearance did not warrant an attempt at biopsy, and the bronchoscopist's opinion was 'probable right lung abscess.'

While in the hospital, 20 minims of potassium iodide was administered by mouth four times daily, and 3 grains of bismuth salicylate intramuscularly every five days. No other procedures in the way of diagnosis or treatment were considered indicated with the patient in the hospital, and he was referred to the outpatient anti-syphilitic clinic for further treatment. He returned to this clinic on two occasions, receiving treatment each time after which he was confined to his bed at home. The city physician made several visits to his home, and the course until death was that of slowly developing lung abscesses on both sides with a terminal septic pneumonia.

NECROPSY

Aside from the pulmonary findings and two small abscesses on the anterior surface of the liver, there were no important pathologic changes observed.

Gross—The upper and middle lobes of the right lung are covered with a thick hyalinized pleura. This portion of the lung is firm and cartilaginous in consistency. On section, there is a large cavity measuring 12 centimeters in diameter of the middle of the upper lobe. This

cavity has well-defined walls which are lined with a grayish-brown necrotic exudate. The lumen is filled with an exudate in which there are small friable and granular masses of debris which measure from 1 to 10 millimeters. Two smaller cavities measuring 2 and 5 centimeters, respectively, are near the larger cavity and have a similar appearance. There are dense hyalinized bands of connective tissue extending from the hilus toward the periphery, surrounding all the cavities and the bronchi, and replacing most of the normal lung tissue. This area of fibrosis is not circumscribed but gradually fades out into the substance of the lung before it reaches the pleura. There is a moderate increase in fibrous connective tissue in the lower lobe which contains several small areas of consolidation, grayish-brown in color and varying in size from 1 to 3 centimeters in diameter. Hilus nodes are filled with anthracotic pigment. In the posterior portion of the left lung there are multiple small grayish areas of consolidation from 1 to 2 centimeters in diameter.

Microscopic—There is an extensive proliferation of fibrous connective tissue in the lung, which has destroyed many alveoli in the upper and middle lobes. Coagulation and liquefaction necrosis of the lining tissue of the cavity are extensive. This necrotic debris is undergoing organization with many thin-walled capillaries surrounded by an infiltration of numerous lymphocytes, plasma, and endothelial cells. Fibroblasts are numerous. Reversion of alveolar epithelium is extensive. Alveoli are filled with an exudate consisting of fluid, plasma, and endothelial cells. Most of the blood vessels of the lung are surrounded by similar cells. Hypostatic pneumonia is present in the lower lobe of the right lung and in the posterior portion of the left lung. The final diagnosis was syphilitic gumma of the lung with surrounding syphilitic pneumonia, multiple lung abscesses, purulent bronchitis, abscesses of the liver, and acute degeneration of the viscera.

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SOME FEATURES OF A CASE OF MULTIPLE EXOSTOSES—DIAPHYSEAL ACLASIS (KEITH)

By N. M. MATHESON, F.R.C.S.,

Central Middlesex County Hospital, London

The patient, G. B., an undersized man of 58 years, was admitted to the hospital suffering from cerebral concussion, the result of a motor accident. All limbs were greatly misshapen, and a later inquiry elicited the following facts.

The patient was the youngest of a family of eleven children, none of whom showed any bony abnormalities. As far as could be ascertained, no parental relatives were similarly afflicted, but the patient's only child, a girl, developed swellings on the inner side of each knee at the age of 6 years and six months. She died of influenza three years later.

The general health of the patient was good and he has had no illnesses of a serious nature. The deformities of the limbs, which first attracted attention, in the region of the knees when the patient was three years old, "progressed to other joints, but ceased when growth stopped at the age of 12 years." They were never painful and caused little real disability, the patient being able to carry on his work as a surveyor.

The patient, whose height measured 5 feet 1 inch, was grossly deformed. There was marked irregularity in the contour of the arms, particularly at the wrists, and in the upper half of each humerus. The right radius was bowed with the convexity outward. Immediately below the knees and just above the ankles, large projections could be seen. The metaphyseal areas were the sites of the most pronounced deformities, which showed a remarkable similarity in corresponding parts of each limb.

Movements at the joints were surprisingly free and painless, and examination of the other systems revealed no notable features. No clinical evidence of endocrine abnormality was detected, and the Aschheim-Zondek test was negative. Radiological examination confirmed the diagnosis of diaphyseal aclasis, and showed the well known features of the disease. The characteristic changes were, as usual, best seen at the sites of maximum growth in the long bones, and their symmetry was striking. The epiphyses were of normal shape, likewise the vertebral skull, and sternum.

The accompanying skiagram (Fig. 1) shows the condition in the right pectoral region where two of the exostoses seem worthy of comment.

Originating from the inferior margin of the glenoid cavity is a cauliflower exostosis representing an excrescence in the neighborhood of

a secondary center of ossification. This swelling could be readily felt in the axilla. Scapular exostoses are not uncommon and occur most frequently in the region of the vertebral border. Reference is often made to irregularity of the ribs, and definite outgrowths are sometimes recorded. The symptomless costal exostosis in the present case was also palpable. It ap-



Fig. 1. Roentgenogram of the right pectoral region showing the costal and the scapular exostoses alluded to in the text.

exostoses are not uncommon and occur most frequently in the region of the vertebral border.

Reference is often made to irregularity of the ribs, and definite outgrowths are sometimes

appeared as a mushroom-shaped projection arising from the posterior part of the right first rib near the tubercle—also the site of a secondary ossific center.

NON-TROPICAL SPRUE

(CHRONIC IDIOPATHIC STEATORRHEA)

In the minds of most North American physicians, sprue has always been considered a specific tropical disease, endemic in character, which is rarely if ever encountered among natives of temperate climates. During recent years, however, an increasing number of reports of sprue-like diseases occurring in non-tropical climates have appeared in the literature, and there are now probably well over a hundred such cases on record. It is probably considerably more common than generally believed. There has been no uniformity in the nomenclature used in describing the condition, and it appears variously as "non-tropical sprue," "idiopathic steatorrhea," "adult celiac disease," "Gee-Herter's disease," and so forth.

The condition is one of particular interest because of its relation to deficiency diseases and because of the present interest in the pathologic physiology of the small bowel. The principal clinical features of the disease are (1) steatorrhea, with or without diarrhea, (2) gastrointestinal disturbances, (3) loss of weight and muscular wasting, (4) defective metabolism of calcium and phosphorus, leading in certain cases to tetany and osteoporosis, (5) physical stunting or rachitic stigmata, and (6) anemias of various types and degrees of severity. Among the most remarkable features of the disease is the variability of the clinical picture and the tendency to remission and relapse.

It has been suggested that the disease is of an infectious nature, but there is no bacteriologic or pathologic evidence to support this view. The condition may represent a true deficiency disease, and the recent work of Rhoads and Miller¹ seems to indicate the validity of this hypothesis. Their studies on tropical sprue seem to show that the condition may arise in three ways: (1) by dietary deficiency in respect to the extrinsic factor; (2) by lack of the same gastric enzyme which is

absent in pernicious anemia, and (3) by inability to absorb the product of interaction of the first two. It is assumed that differences in the relative importance of each factor may be responsible for variations in the clinical picture. A third conception of the disease, which is perhaps more useful to physicians practising in non-tropical climates, and of particular interest to roentgenologists, is that the syndrome of sprue may not necessarily constitute a specific entity but may be produced by various diseases of the small bowel, by various deficiency states, or by any condition that seriously interferes with absorption from the upper portion of the intestinal tract. Fairley and Kilner² have shown that gastrojejunocolic fistula can produce symptoms closely comparable to those of sprue.

The evidence in favor of a deficiency state is very strong and constitutes the best single explanation for the etiology of both the tropical and non-tropical forms of the disease. Whether this deficiency is a primary or secondary condition is as yet uncertain. Until further information in regard to the functional and anatomic disturbances of the small intestine in both conditions becomes available, the interrelation of the non-tropical and tropical varieties of this syndrome will remain an unsettled problem. In this regard the roentgenologist has an opportunity to play a significant rôle. Thaysen³, who, because of his extensive studies in this field may be regarded as an authority, inclines to the belief that celiac disease in children, tropical sprue, and the non-tropical variety are closely related if not identical, and suggests their grouping under the head of "the celiac affection."

References to roentgenologic studies of the gastro intestinal tract in tropical sprue are con-

¹ Rhoads, C. P., and Miller, D. K. Intensive Liver Extract Therapy of Sprue. *Jour. Am. Med. Assn.* Aug. 11, 1934, 103, 187-191.

² Fairley, N. H., and Kilner, T. P. Gastrojeuno-colic Fistula with Megalocytic Anemia Simulating Sprue. *Lancet*, Dec. 19, 1931, 2, 1335-1341.

³ Thaysen, Th. F. Hess. Non-tropical Sprue. A Study in Idiopathic Steatorrhea. Levin and Munksgaard, Copenhagen, 1932. 258 pages.

fined largely to an article by Pillai and Murthi,⁴ who studied nine cases. They found in the acute forms no indication of loss of tonus or motility or other change in the stomach or intestine. In the subacute state there was slight loss of tonus and vigor of peristalsis of the stomach, with consequent delay in passage of its content. The same was true of the cecum and colon. The small intestine emptied rapidly and spots of barium retained in the upper part of the cecum were interpreted as evidence of ulceration. In the chronic state, changes were similar but more marked. There was no evidence of local ulceration of the small bowel.

Roentgenologic observations reported in the literature concerning the non-tropical variety have been limited to the gastro intestinal tract and skeletal system, chiefly the latter. Osteoporosis and osteomalacia have been noted frequently, and it is interesting that these changes are comparable to those observed in cases of avitaminosis and hunger osteomalacia. Dilatation and redundancy of the colon have been commonly observed. Radl and Fallon⁵ were the first to record roentgenologic abnormalities of the stomach and duodenum in non-tropical sprue. In their case marked narrowing of the second and third parts of the duodenum, which suggested ulceration with periduodenal adhesions, was noted. An ulcer was also observed in the first portion of the duodenum, and this produced gastric retention for which gastro enterostomy was done. Mackie⁶ reviewed the general literature of non-tropical sprue and reported one case in which roentgenologic studies revealed dilatation of the coils of the jejunum and small intestinal hypomotility. Independently Snell and Camp⁷ had reported in detail concerning definite roentgenologic changes observed in the stomach and small intestine in four of a group of seven cases of non-tropical sprue. These authors state

'It is significant that in all of the cases in this

group in which we were able to make an adequate study of the intestinal tract during the active stages of the disease, definite roentgenologic changes in motility and in the appearance of the mucosa of the small intestine were observed. Changes in the stomach and colon were less constant. In the usual case the duodenum was dilated and the mucosal markings were thickened. In the jejunum and ileum there was a definite smoothing out of the irregular shadows of the valvulae conniventes, and clumping of the barium in smooth, sausage-like masses. After the bulk of the opaque meal had passed, remnants of barium adhered to the walls of the jejunum, giving it a peculiar 'fleck-like' appearance. In the more severe cases the markings of the valvulae conniventes were entirely lacking. Dilatation of the jejunum was common, although the contractions incident to peristalsis were readily observed fluoroscopically. Hypomotility was the rule in active cases. The regression of the changes and restoration of the mucosal pattern toward the normal, coincident with improvement in the clinical symptoms, were quite striking.

'The roentgenologic findings suggest an inflammatory condition, with edema of the mucosa involving, especially, the small intestine and, less frequently, the stomach and colon. The complete absence of mucosal markings in the severe cases suggests destruction or atrophy of the mucous membrane. The regression of these changes incident to clinical improvement and the changes described at necropsy in similar cases would seem to substantiate these deductions, although it is recognized that there is considerable discussion concerning the significance of the postmortem findings.

'It is not held that these roentgenologic observations are characteristic only of non-tropical sprue, since they may occur in varying degrees in any diffuse inflammatory condition of the intestinal tract. Their presence, however, constitutes tangible evidence during life of alterations in the gastro intestinal tract in this disease which have been suspected clinically and confirmed at necropsy.

Mackie and Pound,⁸ in a roentgenologic and clinical study of changes in the gastro intestinal tract in deficiency states, observed roentgenographic changes in the small intestine in 29 of 37 cases of chronic ulcerative colitis and in

⁴ Pillai M. J. S. and Murthi K. N. Radiological Signs in Cases of Sprue. A Study of Nine Cases. Indian Jour. Med. June 1931, 12, 116 abstr. in Trop. Dis. Bull., January 1932, 29, 8.

⁵ Radl, R. B. and Fallon, Madeleine. Non tropical Sprue, with Duodenal Involvement and Tetany. Arch. Int. Med. October 1932, 50, 595-604.

⁶ Mackie, T. T. Non tropical Sprue. Med. Clin. of No. Am. July 1933, 17, 165-184.

⁷ Snell A. M. and Camp John D. Chronic Idiopathic Steatorrhea. Roentgenologic Observations Presented before Minnesota Society of Internal Medicine, Minneapolis May 15 1933. Published in Archiv. Int. Med. April 1934, 53, 615-629.

⁸ Mackie T. T., and Pound R. E. Changes in the Gastro-intestinal Tract in Deficiency States. Jour. Am. Med. Assn. Feb. 23 1935, 104, 613-618.

three cases of non-tropical sprue. Their observations in the latter group confirmed those reported by Snell and Camp. More recently Snell, Camp, and Watkins¹ have reported 15 cases of non-tropical sprue in which the roentgenologic changes in the gastro intestinal tract confirmed their original observations.

According to Mackie and Pound, "the nature of these phenomena are obscure. Three different mechanisms may contribute. They may result from actual infection of the intestinal wall,

¹ Snell, A. M., Camp, John D., and Watkins, C. H. Non tropical Sprue (Chronic Idiopathic Steatorrhea). Proc. Staff Meetings of Mayo Clinic, March 20, 1935, 10, 177-184.

they may depend on local allergy, or they may represent an effect of the deficiency state. Demonstration of the changes in the small intestine raises the two fundamental questions of their importance and their relation to the deficiency syndrome. They are constantly present and most marked in the cases showing advanced deficiency states. In the milder cases the parallelism is not exact. While the evidence does not warrant definite conclusion, the observations suggest that these changes in the small intestine are related to deficiency states and perhaps play a rôle as a conditioning factor in their development."

JOHN D. CAMP, M.D.

ANNOUNCEMENTS

GRADUATE STUDY IN RADIOLOGY

The College of Medicine of the New York University offers opportunity for graduate study in radiology and grants the degree of Doctor of Medical Science (M.D.Sc.D.) to those candidates who satisfactorily meet the requirements.

Minimum Requirements for Admission

- 1 Graduation from a medical college approved by New York University
- 2 Completion of an internship of at least one year in a hospital approved by New York University
- 3 Approval by the department in which the graduate work is to be done

Requirements for the Degree

- 1 A period of study totalling not less than three years of full time work or the equivalent in New York University or in laboratories or hospitals recognized by it, at least one year of which must be spent in the Medical College of New York University
- 2 A satisfactory performance in written, oral, and practical examinations and an acceptable thesis based on original work

For further information address the Assistant Dean, 477 First Avenue, New York City

A CORRECTION

INTENSITY AND DOSAGE NEAR RADIUM NEEDLES. By G. C. Laurence, Ph.D. RADIOLOGY, August, 1935 25, 166-181

The author is indebted to the Editor of

RADIOLOGY for the opportunity of correcting errors in the text. The formulæ on page 179 should read,

$$f_1 = \frac{1}{\left(\frac{w}{L}\right)} \tan^{-1} \left\{ \frac{w}{L} / \left(\left(\frac{w}{L} \right)^2 + \left(\frac{\lambda}{L} \right)^2 - \frac{1}{4} \right) \right\},$$

which approaches $L^2/(w^2 + \lambda^2)$ at great distance from the needle, and

$$f_2 = \log_e \left\{ \cot \frac{1}{2} \tan^{-1} \left(\frac{\lambda}{w} + \frac{L}{2w} \right) / \cot \frac{1}{2} \tan^{-1} \left(\frac{\lambda}{w} - \frac{L}{2w} \right) \right\} / f_1 \frac{w}{L}$$

NEXT ANNUAL MEETING

HOTEL STATLER, DETROIT, DEC. 2-6, 1935

It is hoped that all members of the Radiological Society of North America have made plans to attend. From the scientific program and exhibits they will derive knowledge, new ideas, new impetus as the case may be. From the commercial exhibit they will learn of advancements and improvements in apparatus, equipment, and contrast media.

Not to be set forth in such concrete terms yet none the less real are the advantages to be derived from contacts with fellow radiologists. Not every one cares to admit as much, but pleasure seems to some of us to be a legitimate end in itself. After months of hard work and close confinement to office or hospital practice it does one no harm to relax a little, meet old friends, and exchange ideas.

Recognizing these diverse needs of radiolo-

fined largely to an article by Pillai and Murthi,⁴ who studied nine cases. They found in the acute forms no indication of loss of tonus or motility or other change in the stomach or intestine. In the subacute state there was slight loss of tonus and vigor of peristalsis of the stomach, with consequent delay in passage of its content. The same was true of the cecum and colon. The small intestine emptied rapidly and spots of barium retained in the upper part of the cecum were interpreted as evidence of ulceration. In the chronic state, changes were similar but more marked. There was no evidence of local ulceration of the small bowel.

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⁵ Radl, R. B., and Fallon, Madeleine. Non tropical Sprue, with Duodenal Involvement and Tetany. *Arch Int Med* October, 1932, 50, 595-604.

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⁸ Mackie, T. T. and Pound, R. E. Changes in the Gastro-intestinal Tract in Deficiency States. *Jour Am Med Assn*, Feb 23 1935 104, 613-618.

can utilities, and also certain social affairs. As for the men, there will be a Counselors' Dinner and a stag night, occasions about which traditions of good-fellowship have grown up through

apparatus men recognize the value to them of this opportunity to show what has been developed

If space has not been reserved for you



Hotel Statler Detroit, where the Annual Meeting is to be held
Dec 2-6, 1935

the years we have been meeting together. The latter offers new men a rare opportunity to make valuable friends.

There has been an unusually active demand for commercial exhibit space, showing that the

before this date, readers would do well to wire for reservations when they read this. Names of Detroit hotels, together with rates, are to be found in October RADIOLOGY, page 508.

COMMUNICATIONS

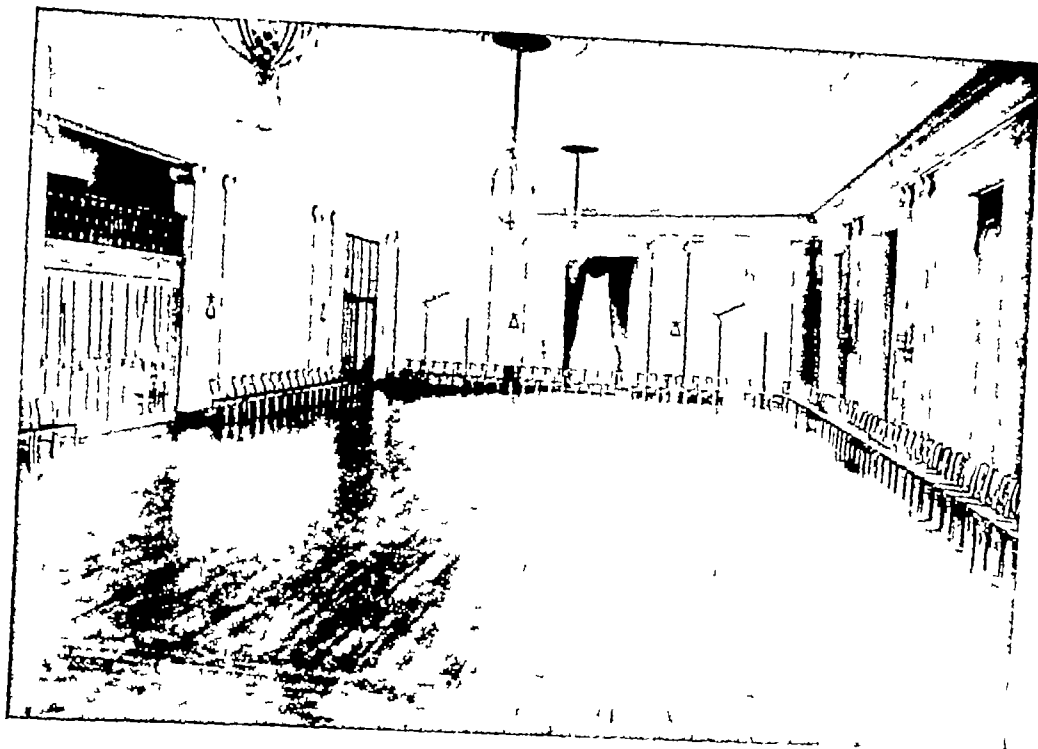
FLORIDA STATE MEDICAL ASSOCIATION

It is always gratifying when a radiologist is chosen by his fellow members to fill an outstanding place in his local, state, or national medical body. The JOURNAL wishes to call attention to such an instance wherein O. O. Feaster, M.D., radiologist at St. Anthony's Hospi-

tal, St. Petersburg, Florida, has been chosen President-elect of the Florida State Medical Association. Dr. Feaster was one of the organizers of the Florida Radiologic Society.

MID-SUMMER RADIOLOGICAL CONFERENCE, DENVER

All concerned with this project are gratified over its successful achievement, and, therefore, it is a matter of gratification to the Editor of



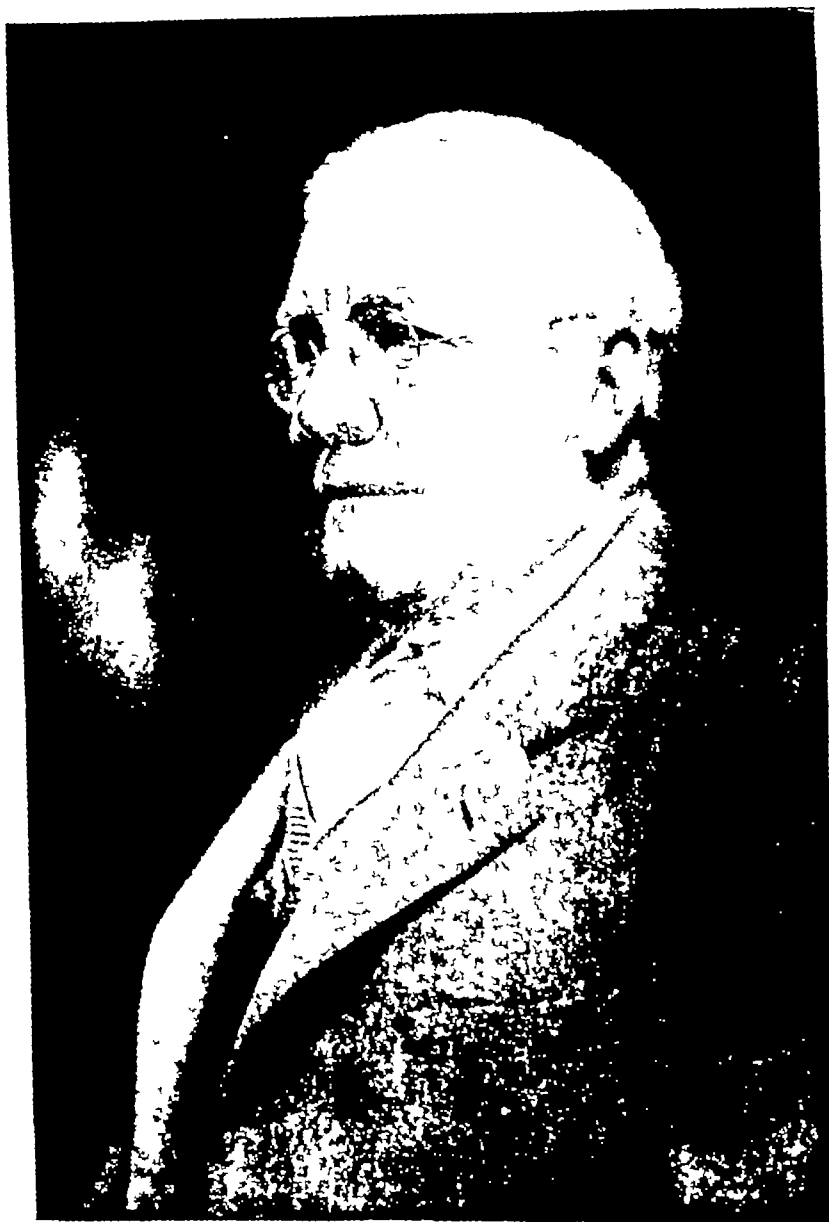
Ballroom, Hotel Statler Detroit, scene of the Society's annual banquet



Dining room Hotel Statler Detroit

gists—in common with the rest of mankind—the committees in charge of our Annual Meeting have provided program, exhibits, entertainment in due parts Every year a few ladies

choose to come and such as visit Detroit will find that the wives of the local physicians have planned for them a visit to Mr Henry Ford's Greenfield Village and museum of early Ameri-



The late JOSEPH COLT BLOODGOOD, M.D., Johns Hopkins Hospital
and University, Baltimore

RADIOLOGY to have received letters from two members of the Radiological Club of Denver saying that the notices in this JOURNAL were instrumental to that end. The JOURNAL is ready at all times to co operate with sectional radiological associations, among whose members the Radiological Society of North America is represented

ORTHOPEDIC LIBRARY

The Medical Institution, of Liverpool, England, is commemorating the work of two famous surgeons by forming a Hugh Owen Thomas and Robert Jones Library of Orthopedic Surgery in which, it is hoped, every phase of that branch of surgery will be represented. An appeal is, therefore, made through the Liverpool Medico surgical Journal for contributions of books and articles on the subject. These will form the nucleus of what, it is hoped, will be a complete Orthopedic Library in which the student, the post-graduate, the physician, the surgeon, and the radiologist may learn all that is being done in this branch of the work, and may refresh themselves at the spring of knowledge which flows from the works of the two men in whose names the Library is being founded.

The fame of Hugh Owen Thomas and Sir Robert Jones will live high amongst the names of the great surgical figures of all time. They have left imperishable records in the history of surgery, and they have formed a science where none previously existed. They have lit a beacon whose light has spread to every corner of the surgical world, and have opened up a prospect of recovery in the hearts of thousands who would otherwise be destined to useless cripple-dom.

They have done this through the force of their teaching and examples, but they have done more in that they have laid down the unalterable basis of treatment on which the inevitable progress will be founded.

It is hoped, therefore, that all who read this, who have themselves contributed toward the literature of orthopedic surgery, will send to the Liverpool Medical Institution a copy of their books or articles to help in the formation of the Hugh Owen Thomas and Robert Jones Library, so that this effort, which is unique, may also be complete in its accomplishment.

It is medicine's proud boast that "science knows no boundaries," so this appeal for books

may find many responses among American radiologists. The address of the Medical Institution is 114 Mount Pleasant, Liverpool 3, England.

IN MEMORIAM

JOSEPH COLT BLOODGOOD, M D

The actual clinical study of cancer by research methods had just begun when Dr Joseph C Bloodgood started his work at Johns Hopkins Hospital. The beginnings in this hospital were forty years ago, when a laboratory was started in connection with the operating room. Pieces of tumors were brought there for study after operation, and records kept. In connection with this study Dr Bloodgood brought laboratory examination into the operating room. The microscope was placed at the operating table. By this method countless legs, arms, breasts, and other organs have been saved from mutilation, and many deaths prevented. The profession as a whole had not been educated in this branch of medical science, and had not learned to employ the microscope in the study of the living patient. By advocating control of therapeutic procedures on the breast and bones in particular, Dr Bloodgood rendered an invaluable service in the treatment of these diseases. His interpretation of chronic cystic mastitis and of giant-cell tumors of the bone as benign lesions, and his advocacy of microscopic study before radical procedures were attempted have saved hundreds of patients throughout the world from needless mutilation.

It was soon found possible to advance the interpretation of laboratory studies made on patients while still in the hospital by extending the record, not only throughout their stay, but by following the patients with letters from time to time for the rest of their lives. Dr Bloodgood instituted, about 1910, an extensive follow-up system in connection with all cancer patients. In the next twenty years many thousands of dollars were spent privately, in addition to the hospital contributions, in keeping records and in following patients by letter. By this method, and by microscopic studies many fundamental contributions have been made. The thoroughness with which records and material from cancer cases have been recorded and preserved makes this laboratory a most valuable library for all those undertaking

ness in measuring the relative intensities of the rays

This book states that it "calls attention to those aspects which seem of the most fundamental physical significance." It is an excellent and comprehensive presentation of what is known in the roentgen-ray field at the present time

MANUAL OF RADIOLOGICAL TECHNIC L. R. SANTE, M.D., Professor of Radiology, St. Louis University School of Medicine, Radiologist to St. Louis City Hospital and St. Mary's Hospital, St. Louis. Published by Edwards Brothers, Inc., Ann Arbor, Michigan, 1934. A volume of 157 pages, with 141 illustrations. Price, \$4.50.

Many roentgenologists, particularly those associated with large institutions or medical schools, have undoubtedly had a desire at one time or another to compile for the use of their students and technicians a manual of roentgenographic technic. Dr. Sante has carried this idea to completion and produced a manual of x-ray technic designed to serve, first, the radiologist who, in his administration of a large department of radiology, is constantly called upon to train and supervise large groups of

technicians, second, the technician himself, and third, the general medical profession.

The first eight chapters are devoted to a short historical sketch concerning the discovery of the x-rays, and a practical and concise consideration of the physics of magnetism and electricity, the x-ray tube, and the production of x-rays, the physical properties of x-rays, the calibration of x-ray machines, the essential factors of radiography, radiographic procedure, and dark room technic. Many of these chapters contain useful, practical information not heretofore found in books of this sort.

The major portion of the manual is devoted to a discussion of the standard positions for all phases of radiography. This section is excellently illustrated by photographs, roentgenograms, and anatomic drawings. A unique and most valuable feature of this part of the manual is a discussion termed "Roentgenological Consideration" which appears for each position portrayed.

To make the manual more elastic it has been published by the lithoprinting method which makes it possible for any radiologist to eliminate any particular procedure or technic which he does not desire and to introduce additional rules or regulations particularly applicable to his own department, at very small cost.

IN MEMORIAM

HARRY B. PODLASKY, M.D.

Word has been received of the death, on November 8, of Harry B. Podlasky, M.D., of Milwaukee, Wisconsin. Dr. Podlasky has been an honored member of the Radiological Society of North America, among whose members are numbered many who will be grieved to learn of his passing. He was a member of the Editorial Staff and a contributor to RADIOLOGY.

We hope to print a sketch of Dr. Podlasky in the next issue.

serious investigation on the cause or control of cancer

In the study of the records it soon became manifest that much of the material saved dealt largely with the terminal stages of cancer. This fact, together with the fact that the examinations recorded and made in the hospital were often too meager, hindered progress. To obtain worthy scientific records and to see patients in all phases of cancer, a new movement was started. It was decided to educate the profession and the public in the early signs and symptoms of cancer so that the patients would come for consultation at the beginning of the disease.

One of Dr. Bloodgood's chief interests has been the spreading of information among the laity concerning those aspects of cancer which are influential in bringing suspected cases of cancer under the observation of the physician at the first signs of the disease, when it is still in its curable stages. This educational effort in the field of cancer, which was started some seventeen years ago by such pioneers as Cullen and Bloodgood and is being continued by the American Society for the Control of Cancer and by special State organizations such as those in New York and Massachusetts, has brought about changes in the clinical aspects of cancer, which are rapidly revolutionizing practice in this sphere of medicine.

This work stands as an enduring memorial to Dr. Bloodgood, who passed away Oct. 22, 1935. His name is an honored one among radiologists, many of whom not only respected his broad knowledge and experience, but felt his personal charm and genial humor.

RADIOLOGY pays honor to his memory

BOOK REVIEWS

X-RAYS IN THEORY AND EXPERIMENT By ARTHUR H. COMPTON, PH D., Sc D., LL D., Nobel Laureate, 1927, Charles H. Swift Distinguished Service Professor of Physics, University of Chicago, and SAMUEL K. ALLISON, PH D., Associate Professor of Physics, University of Chicago. Second Edition of "X-rays and Electrons," by Arthur H. Compton. A volume of 828 pages, with 279 illustrations, cloth. D. Van Nostrand Company, Inc., New York, 1935. Price, \$7.50.

A. H. Compton published his well-known book, "X-rays and Electrons," in 1926. It

quickly gained wide favor among physicists. After its publication there were new and important developments of the theories underlying roentgen-ray phenomena, and so Compton prepared a revised and more comprehensive edition, presenting the newer roentgen-ray experiments and theories in co-operation with S. K. Allison. Compton wrote the introductory chapter and the chapter on scattering. In the preface he gives his collaborator credit for the preparation of the greater part of the book which includes discussion of roentgen rays and crystals, dispersion, absorption, and roentgen-ray spectra.

The book is not exactly easy reading for the average medical roentgenologist. It contains much valuable information not only on points of general interest about roentgen rays but also in the field of practical application in roentgen diagnosis and therapy. A list of the main chapters gives an idea of the vast territory covered.

Chapter I The Discovery and Properties of X-rays,

Chapter II The Production of X-rays,

Chapter III The Scattering of X-rays,

Chapter IV Dispersion Theory Applied to X-rays,

Chapter V The Study of Crystal Structure by Means of X-rays,

Chapter VI The Intensity of Reflection of X-rays from Crystals,

Chapter VII Phenomena Associated with the Ejection of Photo-electrons by X-rays,

Chapter VIII The Interpretation of X-ray Spectra,

Chapter IX Some Accurate Methods of X-ray Wave Length Measurement and Their Results.

Numerous appendices contain mathematical deductions and formulæ, tables of atomic constants, wave lengths of roentgen ray spectrum lines, critical absorption wave lengths, absorption coefficients, etc.

The roentgenologist will be especially interested in the chapters on production and measurement of the roentgen rays. The production of the continuous and characteristic x-ray spectra and their dependence upon voltage, target material, etc., is discussed in detail. Measurement of the roentgen rays by studies of their absorption and scattering in various media as well as by x-ray spectroscopy are explained at great length. Of particular interest is the discussion of the ionization in gases and its useful-

APPARATUS

Thicknesses of Aluminum to be Used in Addition to Copper Filters A Mutscheller *Am Jour Roentgenol and Rad Ther*, July, 1934 32, 92, 93

The most efficient filter of aluminum to be used as a secondary filter to absorb the characteristic soft radiation emitted by the copper filter would be that thickness of aluminum just sufficient to absorb such soft radiation. Experiments by Mutscheller showed that a filter of $\frac{1}{4}$ mm or, at the most $\frac{1}{2}$ mm of aluminum is quite sufficient to absorb all harmful radiation arising from the $\frac{1}{4}$ mm of copper and that no useful results are gained from any additional material.

J E HABBE, M D

A New Method of Measuring the Short Rays in the Sun Spectrum Julius Brinkmann *Strahlentherapie*, 1935 53, 424-454

The method is based on measurements with a set of double thermocouples arranged according to the compensation principle in connection with adequate filters. The output of a quartz mercury vapor lamp was also determined and found to be 2.9×10^{-5} watt per sq cm at 1 meter distance.

ERNST A POHLE, M D, Ph D

Regarding the Additional Aluminum Filter in Roentgen Therapy M Grunberg and W Johner *Strahlentherapie* 1935 53, 528-535

Measurements of the secondary irradiation from copper filters within and outside of the primary beam showed that for FSD of 20 cm and more this radiation may be neglected. The addition of an aluminum filter in deep therapy after filtration of the primary radiation through 0.5-3 mm Cu is therefore, superfluous.

ERNST A POHLE, M D, Ph D

Our Experience with New Siemens Momentan Dosage Meter Herbert Aretz *Strahlentherapie* 1935 53, 536-542

The author briefly describes an ionization instrument which permits the determination of the output of an x-ray tube in r/min. A double scale is provided for 0-12 r and 0-100 r/min. The instrument is said to be easy to operate and has a radio active standard for checking the calibration.

ERNST A POHLE, M D, Ph D

Scattered Radiation Emitted by Patients Undergoing Roentgen Deep Therapy H W Ernst and Paul Ott *Strahlentherapie* 1935 53, 495-504

The authors measured the scattered radiation emitted by a patient subjected to roentgen deep therapy using the new type of Siemens dosimeter with a cellophane

chamber. The latter is supposed to be independent of the wave length within the spectral region examined. After a brief orientation as to the distribution of the scattered radiation emitted by the patient by means of a pinhole camera the rays were measured at 50-200 cm distance within and without the primary beam. Based on Mutscheller's tolerance dose it appears that during a treatment the operator should not enter the therapy room. However due to the longer wave length of the secondary radiation a lead rubber apron as customary in fluoroscopic work, suffices for the protection of the physician. At one meter distance from the patient and behind such a lead rubber apron the dose is $4-5 \times 10^{-5}$ r per second.

ERNST A POHLE, M D, Ph D

CANCER (THERAPY)

Post operative Irradiation in Carcinoma of the Breast G Schwarz *Strahlentherapie* 1935, 53, 674-681

Several cases have been observed and published wherein skin metastases appeared in the anterior breast region following radical removal for carcinoma after very heavy doses of roentgen rays had been applied post-operatively. The metastatic nodules were limited to the irradiated skin area. The author has used for several years, therefore, a "milder" procedure. In the first place he advocates a fairly soft radiation (100 kv 1 mm Al) because the skin is injured less. One series consists of from six to eight sittings given daily, with a total dose of from 900 to 1,200 r applied over the anterior chest. If possible one large area is given to the axillary and supraclavicular region at 70 cm FSD. If the arm cannot be raised sufficiently two separate areas are used at 40 cm FSD. He repeats the series every five weeks so that five months after operation a total of from 3,600 to 4,800 r has been applied. After the sixth month the intervals between series are increased to three, six, and twelve months adding each time 1,200 r. The experience with this treatment has been very satisfactory.

ERNST A POHLE, M D, Ph D

Curietherapy of Carcinoma of the Mouth and Pharynx V Palumbo *Strahlentherapie* 1935, 53, 651-657

In the treatment of intra oral lesions the author uses external telecurietherapy followed by direct (local) irradiation and again followed by external telecurietherapy. Twenty years experience has convinced him that the results obtained by irradiation are far superior to those of surgery. No technic is given.

ERNST A POHLE, M D, Ph D

GASTRO-INTESTINAL TRACT
(DIAGNOSIS)

Duodenal Diverticula L Minucci del Rosso II Polichinico (Sez. Chir.) April 15 1935, 42, 236-260
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ABSTRACTS OF CURRENT LITERATURE

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ments using a Küstner instrument with large chamber in eight diagnostic, eight deep therapy roentgen departments in two non medical research institutes, one super high voltage installation and one radium institute. The tolerance dose of Mutscheller was used as basis for his comparisons. It is equivalent to 0.25 r for an 8-hour working day. In fluoroscopic rooms the dose in the neighborhood of the patient is higher than the tolerance dose, however it can be overcome by adequate lead rubber protections. In deep therapy the scattered radiation emitted by the patient may be particularly for large treatment areas as high as twenty times the tolerance dose. It is necessary, therefore, to place the operator of the machine in a protected room. 22.5 mm of lead offered sufficient protection against irradiation from 160 mg of radium enclosed in a lead lined safe.

ERNST A. POHLE M.D., Ph.D.

RADIUM

Radium Therapy of Carcinoma of the Tonsils and Pillars. Angelo Santoro d'Emidio. *Strahlentherapie* 1935, 53, 658-673.

The author briefly discusses the method of Coutard and telecurietherapy in the treatment of carcinoma of the tonsils and pillars. His own technique consists of the application of five radium tubes containing 2 mg each. They are introduced in the tissue at an average distance of 15 cm (this should probably be mm), and left *in situ* approximately eleven days. At that time there is definite edema with radio-epithelitis and considerable pain. The symptoms subside however after a few days during which time the patients are on a liquid diet. A careful technique is necessary in order to avoid injury to blood vessels. The cervical glands are irradiated by means of radium applicators placed at 1.5-3 cm distance. In closing the author emphasizes the efficacy of the interstitial treatment method in combination with external irradiation.

ERNST A. POHLE M.D., Ph.D.

Practical Experiences in Radium Dosimetry. I—General Remarks. H. Holthusen. *Strahlentherapie* 1935, 53, 743-751.

II—Our Experience with the Photometric Method of Dosage in Radium Practice. A. Hamann. *Strahlentherapie* 1935, 53, 752-773.

Although photometric methods are not reliable for roentgen dosimetry the author of Part I has found them accurate enough in practical radium dosimetry. He briefly outlines the development of the method in his laboratory and discusses its clinical application.

In the second part of this contribution Hamann describes in detail the technical procedure of the photographic method used in the determination of radium doses. Briefly it consists of the exposure of diagnostic Affra film about 6 sq cm in size placed under a cube of beechwood (length of edge 5 cm) which carried

the radium applicator containing 13.3 mg filtered through 1 mm Pt. Standard films produced in this manner and correlated with the erythema on the skin can then be compared with films produced by exposure to other radium applicators. The test films reveal the degree of homogeneity in a treated skin area, and the determination of isodose curves for radium applicators at various distances can also be done with this method. A table shows the doses used by the author in a number of malignant tumors with data concerning amount and type of radium applied, intensity (in r per minute), and duration of treatment.

ERNST A. POHLE M.D., Ph.D.

THE SPINE

Six Cases of Isolated Disruption Fracture of Spinous Process of Seventh Cervical Vertebra and First Dorsal. V. Bloch. *Ugeskr. f. Læger*, March 21, 1935, 97, 358-360. (Reprinted by permission from *British Medical Journal*, June 29, 1935, p. 103 of *Epitome of Current Medical Literature*.)

The author has observed in his practice six instances of isolated fracture of the spinous process of the seventh cervical (three cases) or first dorsal (three cases) vertebra. All the patients were men between the ages of 25 and 40, engaged as navvies in shovelling frozen lumps of earth up into carts. The clinical picture was remarkably uniform—sudden and violent pain in the nape of the neck and between the shoulder-blades in the act of shovelling. There was tenderness on pressure over the lowest cervical or first dorsal vertebra. The x-rays showed fractures of the spinous processes in the middle or at the junction of the central with the posterior third of the bone. The loose fragment was displaced downward in its entirety or with its most posterior end. In only one case was there no dislocation. Treatment consisted of rest in bed for about three weeks. With only one exception pain was felt on return to hard work several months after the accident. In his study of the literature the author has found a conflict of opinion over the merits of excising the loose fragment of bone in those cases in which pain persists. In a case recorded by Lönnblad the removal of the loose fragment did not banish the pain. According to another authority bony reunion is not to be expected; there is either fibrous union or the fragment of bone remains floating.

Subluxation of the Apophyseal Articulations with Bony Impingement as a Cause of Back Pain. Lec. A. Hadley. *Am. Jour. Roentgenol. and Rad. Ther.* February 1935, 33, 209-213.

Particular consideration is given to subluxation of the apophyseal joints of the lower spine as a cause of back pain following injury. Thinning of an intervertebral disc may not be a direct cause of pain but this symptom may be explained by (1) tension upon capsular ligaments, (2) encroachment upon size of lumen of the foramina, and (3) impingement of the ends of the articular process against the pedicle above and the lamina below. Several cases are illustrated to show the

June 29, 1935, p 104 of *Epitome of Current Medical Literature*)

The author has collected 68 cases of duodenal diverticula in patients aged from 22 to 87, the first of which was reported by Chomel in 1710, and the last two by himself—in a woman aged 61, who had two diverticula and in a man aged 68, who had one diverticulum. As a rule there is only a single one. In 80 per cent of the cases it is situated between the second and third parts of the duodenum, and is confined to the segment of the duodenum corresponding to the pancreas. Islands of accessory pancreas are not infrequently found in the wall of the diverticulum.

According to Sabatini there are three types of clinical syndrome caused by duodenal diverticula. In the first the symptoms are those of duodenal ulcer, the anatomical foundation in such cases being diverticulitis, compression or torsion of the sympathetic, or torsion of the duodenum. In the second type the symptoms are those of acute or chronic pancreatitis and in the third those of inflammation of the gall bladder due to compression of the biliary tract.

Of the author's 68 cases, 22 ended fatally, the chief causes of death being myocarditis, pneumonia, hemorrhage and the shock of the operation. Of 16 cases in which operation (posterior gastro-enterostomy or resection of the diverticulum) was performed, 14 recovered.

Coincident Scirrhus Lesions of the Stomach and Colon. Report of Cases. Marcy L. Sussman. *Am Jour Roentgenol and Rad Ther*, February, 1935 33, 205-208.

The writer reports two cases showing coincident constricting deformities of the stomach and colon, the constrictions being in each case at two levels of the colon while in one there was a localized narrowing of the gastric media and in the other a more diffuse narrowing of the gastric lumen. One case was proven at operation to be scirrhus carcinoma of the stomach with metastases to the bowel. The difficulties of differentiation from hyperplastic tuberculosis, advanced ulcerative colitis or amebic dysentery and non specific granuloma are stressed.

J. E. HABBE, M.D.

GRENZ RAYS

Absorption and Scattering of Roentgen Rays in Air and Cellophane. Hans Küstner. *Strahlentherapie* 1935 53, 605-610.

The author found that the electron emission from cellophane after rendering it a conductor of electricity by means of graphite application equals that of air. It is, therefore, an excellent material for 'air wall' ionization chambers and well suitable for measurements of long wave roentgen rays (Grenz rays). One millimeter of cellophane absorbs roentgen rays of all wave lengths the same as 106.8 cm of air.

ERNST A. POHLE, M.D. Ph.D.

THE LARYNX

A Few End results Following Radiation Therapy of Carcinoma of the Larynx. A. Lambadarides. *Strahlentherapie*, 1935 53, 630-650.

The author discusses the international literature dealing with radiation therapy in carcinoma of the larynx. He presents then an analysis of 27 cases of his own, seen in Athens, Greece, during the period from 1925 to 1933. Only 12 of these had a complete course of irradiation, six were dead at the time of writing and six were alive. The survival periods of the former varied from eight months to three and one half years. Those still alive have been under observation for periods from thirteen months to nine years. Technique: 185-300 kv, 3 ma, 50-60 cm FSD, 1 mm Zn + 2 mm Al, 45-60 sq cm field size, 15-30 sittings in 18-30 days, surface dose 5,000 to 9,000 r with twice the dose on the involved side. Occasional radium therapy was given (1-1.5 mm Pt + 2 mm Al, 3 M.C.D. over 2 sq cm at 4 cm FSD, 11-15 days and nights without interruption). A bibliography with 110 references is appended.

ERNST A. POHLE, M.D. Ph.D.

THE LUNGS

A Roentgenological Study of Pulmonary Ventilation. A Method for the Prediction of Normal Pulmonary Capacities Based upon Roentgen Measurements. Walter W. Gray. *Am Jour Roentgenol and Rad Ther*, February, 1935 33, 170-190.

This writer has attempted to correlate the dimensions of the lung fields obtained teleroentgenographically with clinical determinations of pulmonary capacity. The radiographic technique adopted was a double exposure chest film made with the patient in recumbency, the greater exposure being made at maximum expiration and the lesser exposure at full inspiration. From this film the area measurements of the lung fields at these two phases of respiration were obtained. To obtain the roentgenological chest volume, an anteroposterior chest diameter was obtained with calipers at the level of junction of body of sternum with the xyphoid at maximum inspiration. By multiplying the area of the lung fields at inspiration by this anteroposterior diameter measurement the roentgenologic chest volume was obtained. The best correlation was obtained between the figure and the vital capacity. The formula established is: roentgenologic chest volume $\times 0.24$ plus 1.22 equals predicted vital capacity. A good correlation was also obtained between the lung area at maximum inspiration and both vital and total pulmonary capacities.

J. E. HABBE, M.D.

PROTECTION

Tests of the Protection against Radiation and Scattered Radiation in Eighteen Modern Roentgen Departments. Gerhard Heise. *Strahlentherapie* 1935 53, 574-594.

The author carried out a series of ionization measure-

ments using a Küstner instrument with large chamber in eight diagnostic, eight deep therapy roentgen departments in two non-medical research institutes, one super high voltage installation and one radium institute. The tolerance dose of Mutscheller was used as basis for his comparisons, it is equivalent to 0.25 r for an 8-hour working day. In fluoroscopic rooms the dose in the neighborhood of the patient is higher than the tolerance dose, however it can be overcome by adequate lead rubber protections. In deep therapy the scattered radiation emitted by the patient may be, particularly for large treatment areas, as high as twenty times the tolerance dose. It is necessary, therefore, to place the operator of the machine in a protected room 22.5 mm of lead offered sufficient protection against irradiation from 160 mg of radium enclosed in a lead lined safe.

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value of oblique roentgenograms for determining the size of the foramina and the presence of impingement of the articular processes on the adjacent pedicle or lamina

J E HANNE M D

TUMORS (DIAGNOSIS)

Retropharyngeal Tumors L Natanson *Rev de Laryngol d'Otol et de Rhinol* January, 1935 56, 51-102 (Reprinted by permission from *British Med Jour*, April 6, 1935, *Epitome of Current Medical Literature*)

The author has collected 52 cases of retropharyngeal tumors since the classic work of Heintz, who submitted conclusions based on 34 cases all he had been able to discover in fifty years. The present author's conclusion is that these growths are generally benign in nature except in infants when they are always malignant. As a rule they are of neurogenic etiology (neuromas or neurofibromas) arising from the cervical part of the sympathetic system. A minority are lipomatous and a still smaller minority are primitive goiters. Very probably the tumors of nerve origin represent a local manifestation of von Recklinghausen's disease in an unusual site. Retropharyngeal tumors are often associated with symptoms of sympathetic disturbance particularly of the complete or partial Claude Bernard Horner syndrome. Natanson advises that in any case of doubtful diagnosis a special investigation should be made for the presence of these symptoms and adds that an x ray examination is often most helpful. Growths in this situation have a tendency to extend—an indication for surgical removal particularly since they are fairly easily removable when small. The buccal route is indicated only when the tumor is situated in the mesopharynx and there is no fear of it being goiterous. In all other cases the best route is by a lateral pharyngotomy through an external incision. Provided with a good light and with the patient in a suitable position, it is nearly always possible for the surgeon to avoid the necessity of maxillary resection. Since these tumors are nearly always benign, it is useless to treat them with x rays or radium and such measures will complicate any later surgery that may be found necessary. Only obviously malignant tumors are suitable for radiotherapy.

TUMORS (THERAPY)

Report on Malignant Tumors of the Testicle William Bloom *Strahlentherapie*, 1935, 53, 611-629

Following a brief discussion of pathology, etiology, and diagnosis of tumors of the testicle the author analyzes 20 cases observed since 1925 at the Roentgen Institute University of Zurich. All cases were verified histologically. 85 per cent were seminomas, 10 per cent teratomas and 5 per cent lipomyxosarcoma. The seminoma was most radiosensitive. One case of teratoma lived a year and a half, one eight months and the patient with lipomyxosarcoma three months. Most cases came in at a late stage of the disease often with demonstrable metastases. Operation alone does not seem advisable. Three of the author's patients who did

not receive irradiation returned with huge recurrences within a year after surgical removal of the testicle. The most common sites of metastases were abdomen, lungs and inguinal glands. The survival periods following removal of the testicle and irradiation varied from one month to 45 months in those who died and from six to 88 months in those still alive. The technique used in these cases varied somewhat. Up to 1930 a single dose of 100 per cent H E D was given, followed sometimes by additional treatments four weeks later. Since 1930 the fractional dose method or the protracted fractional dose method has been used. These cases received anywhere from 600 to 29 000 r distributed of course over a number of series. Three cases were irradiated before operation.

An analysis of the entire material leads the author to the recommendation of pre-operative irradiation followed by removal of the involved testicle with intense post-operative irradiation by the protracted fractional dose method. A special paper is appended wherein data on all observed cases are compiled. A good bibliography is given.

ERNST A POHLE M D Ph D

Pre-operative Irradiation of Cortical Renal Tumors Charles A Waters *Am Jour Roentgenol and Rad Ther* February, 1935 33 149-164

The author has been using pre-operative irradiation of cortical renal tumors since 1923, having first reported the results of the pre-operative radiation treatment of nine cases in 1933. In the present article six more cases are added making a total of 15 reported in the literature by this author.

Pyelography is of importance in determining the usefulness of radiation as a pre-operative measure, since tumors of the hypernephroma and embryonal carcinoma type are relatively radiosensitive while the papillary carcinomas of the renal pelvis and the malignant papillary cyst adenomas are radioresistant. It was shown in a critical study of 66 cases of renal tumors in which both microscopic and gross pathologic findings were available, that the roentgen diagnosis of cortical tumors was correct in 90 per cent and of pelvic tumors in 100 per cent of these cases. It is now a routine procedure to make pyelograms of the treated kidney after each series of treatments in order to determine the degree of shrinkage of the tumor. By these serial pyelograms the writers are able to determine by therapeutic test the radiosensitivity of the cortical tumors. While the series is admittedly small, 93.4 per cent of these cortical tumors were found radiosensitive.

A series of treatments ordinarily requires about three weeks for administration. Daily doses varying from 195 to 345 r are given depending upon the reaction of the patient. Deep therapy is employed using 200 000 volts with 0.5 mm copper filtration and a total tumor dose of from 1 600 to 3 500 r is accomplished by employing three—and sometimes four—portals of entry. In the majority of cases blood transfusions have been given following irradiation and preparatory to operation. In all but one case of this series of cortical tumors there

was prompt reduction in size, usually beginning within a few days after starting therapy and continuing for several weeks after cessation of treatment

In some instances a second series is administered. Those cases that do not respond to the first or second series are probably so radioresistant that further therapy is contra indicated.

Pre-operative irradiation diminishes the size of the tumor and allows more freedom of operation. In seven cases the tumor was so large that operation would have been practically impossible at the time the patient was first seen.

In addition to reduction in size of the mass, there also results an extensive fibrosis from the tumor with thickening of the capsule which inhibits expansion of the mass. There is sclerosis of the small blood vessels and the capillaries supplying the tumor, this change being observed principally within and beneath the tumor capsule. Microscopically the cell outlines are indistinct or lost entirely and frequently compressed between connective tissue fibers. The nuclei are smaller and lose their staining qualities. Marked hyalinization and fibrosis occur. Hyalinization, fatty degeneration, and interstitial fibrosis, which are so marked in the tumor area, are strikingly absent in the uninvolved portion of the kidney.

Operative removal is imperative and should be carried out within a few weeks after completing the first (or, if given the second) series, depending upon the degree of shrinkage of the tumor as revealed by palpation and retrograde pyelographic studies. Regrowth of the tumor occurs of course if operation is delayed too long.

J E HABBE M D

Further Observations on the Roentgen Treatment of Pituitary Tumors. George E Pfahler and Edgar W Spackman. *Am Jour Roentgenol and Rad Ther*, February, 1935, 33, 214-226.

While the importance of x rays both in the diagnosis and in the treatment of pituitary tumors is fairly well established and recognized, no fixed rules can be laid down as to which cases should have irradiation therapy and which should be submitted to operation. In general best results are obtained with x rays in the solid pituitary adenomas, the cystic adenomas and other types of tumors responding less favorably. The writers warn against prolonged roentgen therapy beyond the point of practical value or normal tissue tolerance. If in any given case the surgeon and neurologist decide that the case offers a reasonably fair chance of success by operative means, then roentgen therapy may be regarded as of second choice. There are of course certain cases in which the entire tumor mass cannot be removed in which situation the entire hope of preventing regrowth depends upon irradiation.

In the series of 21 cases considered in this paper, 13 were first seen in a stage too far advanced to expect satisfactory results from any form of treatment. It has been rather exceptional to diagnose this disease in an early stage.

Concerning clinical aspects of the cases, the most

universal symptom encountered was headache, 17 of the patients complaining of either generalized headache or pain in the occiput or back of the eyes. This symptom is usually quickly relieved by treatment, many patients being decidedly helped by a single application of the roentgen ray. Visual disturbances of objective character were present in 12 cases. In the early stages contraction of the fields for red before the form fields were correspondingly affected was noted. Often the fields of vision were reduced to one third of normal or less before the patient realized that anything unusual was occurring. In the far advanced cases rapid growth, gigantism, or acromegaly was noted. Five cases showed some form of muscular weakness and four increased thirst and polyuria. Three cases were recognized on routine examination, with no objective knowledge of any of the above symptoms on the part of the patient. The typical bitemporal hemianopsia was not encountered in as large a percentage of cases as might be expected, hence x ray study in all cases of unexplained optic atrophy, contraction of visual fields, or papilledema is clearly indicated.

The series reported represent unselected cases encountered in hospital and private practice.

All cases amenable to roentgen treatment (as shown by expansion of visual fields) will show a favorable response by the administration of 200 per cent 1,600 r, through the usual three portals of entry. When cases do not respond to this amount of treatment they should be considered surgical. This amount of treatment can easily be given within two months. As high as eight to ten erythema doses to each skin portal have been given in some instances, and by carefully limiting the area of the field no unfavorable result has been encountered.

Post-operative roentgen therapy is strongly urged for every case in which surgical removal of the tumor may have been incomplete.

J E HABBE, M D

Indications for Radiation Therapy of Primary Bone Tumors. Ferd Tomanek. *Strahlentherapie*, 1935, 53, 682-709.

This is a review of the literature dealing with the indications for radiation in primary bone tumors. The American literature has been covered well. The article is not suitable for abstracting.

ERNST A. POHLE M D Ph D

ROENTGEN-RAY FILMS (IDENTIFICATION)

The Legal Aspect of Identification and Interpretation of Roentgenograms. I S Trostler. *Am Jour Roentgenol and Rad Ther*, November 1934, 32, 680-693.

In a review of 83 decisions emanating from the highest courts of 30 States, it was found that the legal aspect of identification and interpretation of roentgenograms varied considerably.

It is necessary to impress the courts with the facts that all roentgenograms, whether they be used in court or in clinical medicine, should be properly and unquali-

value of oblique roentgenograms for determining the size of the foramina and the presence of impingement of the articular processes on the adjacent pedicle or lamina

J E HANDE MD

TUMORS (DIAGNOSIS)

Retropharyngeal Tumors L Natanson *Rev de Laryngol, d'Otol et de Rhinol* January, 1935, 56, 51-102 (Reprinted by permission from *British Med Jour*, April 6, 1935 *Epitome of Current Medical Literature*)

The author has collected 52 cases of retropharyngeal tumors since the classic work of Heimatz, who submitted conclusions based on 34 cases all he had been able to discover in fifty years. The present author's conclusion is that these growths are generally benign in nature except in infants when they are always malignant. As a rule they are of neurogenic etiology (neuromas or neurofibromas) arising from the cervical part of the sympathetic system. A minority are lipomatous and a still smaller minority are primitive goiters. Very probably the tumors of nerve origin represent a local manifestation of von Recklinghausen's disease in an unusual site. Retropharyngeal tumors are often associated with symptoms of sympathetic disturbance, particularly of the complete or partial Claude Bernard Horner syndrome. Natanson advises that in any case of doubtful diagnosis a special investigation should be made for the presence of these symptoms and adds that an x-ray examination is often most helpful. Growths in this situation have a tendency to extend—an indication for surgical removal, particularly since they are fairly easily removable when small. The buccal route is indicated only when the tumor is situated in the mesopharynx and there is no fear of it being goiterous. In all other cases the best route is by a lateral pharyngotomy through an external incision. Provided with a good light and with the patient in a suitable position it is nearly always possible for the surgeon to avoid the necessity of maxillary resection. Since these tumors are nearly always benign it is useless to treat them with x-rays or radium and such measures will complicate any later surgery that may be found necessary. Only obviously malignant tumors are suitable for radiotherapy.

TUMORS (THERAPY)

Report on Malignant Tumors of the Testicle William Bloom *Strahlentherapie*, 1935, 53, 611-629

Following a brief discussion of pathology, etiology and diagnosis of tumors of the testicle the author analyzes 20 cases observed since 1925 at the Roentgen Institute University of Zurich. All cases were verified histologically. 85 per cent were seminomas, 10 per cent teratomas and 5 per cent lipomyosarcoma. The seminoma was most radiosensitive. One case of teratoma lived a year and a half, one eight months and the patient with lipomyosarcoma three months. Most cases came in at a late stage of the disease often with demonstrable metastases. Operation alone does not seem advisable, three of the author's patients who did

not receive irradiation returned with huge recurrences within a year after surgical removal of the testicle. The most common sites of metastases were abdomen, lungs and inguinal glands. The survival periods following removal of the testicle and irradiation varied from one month to 45 months in those who died and from six to 88 months in those still alive. The technique used in these cases varied somewhat. Up to 1930 a single dose of 100 per cent H.E.D. was given followed sometimes by additional treatments four weeks later. Since 1930 the fractional dose method or the protracted fractional dose method has been used. These cases received anywhere from 600 to 29,000 r distributed of course, over a number of series. Three cases were irradiated before operation.

An analysis of the entire material leads the author to the recommendation of pre-operative irradiation, followed by removal of the involved testicle with intense post-operative irradiation by the protracted fractional dose method. A special paper is appended wherein data on all observed cases are compiled. A good bibliography is given.

ERNST A. POHLE MD Ph D

Pre-operative Irradiation of Cortical Renal Tumors Charles A. Waters *Am Jour Roentgenol and Rad Ther* February 1935 33 149-164

The author has been using pre-operative irradiation of cortical renal tumors since 1923, having first reported the results of the pre-operative radiation treatment of nine cases in 1933. In the present article six more cases are added, making a total of 15 reported in the literature by this author.

Pyelography is of importance in determining the usefulness of radiation as a pre-operative measure since tumors of the hypernephroma and embryonal carcinoma type are relatively radiosensitive while the papillary carcinomas of the renal pelvis and the malignant papillary cyst adenomas are radioresistant. It was shown in a critical study of 66 cases of renal tumors in which both microscopic and gross pathologic findings were available that the roentgen diagnosis of cortical tumors was correct in 90 per cent and of pelvic tumors in 100 per cent of these cases. It is now a routine procedure to make pyelograms of the treated kidney after each series of treatments in order to determine the degree of shrinkage of the tumor. By these serial pyelograms the writers are able to determine by therapeutic test the radiosensitivity of the cortical tumors. While the series is admittedly small, 93.4 per cent of these cortical tumors were found radiosensitive.

A series of treatments ordinarily requires about three weeks for administration. Daily doses varying from 195 to 345 r are given depending upon the reaction of the patient. Deep therapy is employed using 200,000 volts with 0.5 mm copper filtration and a total tumor dose of from 1,000 to 3,500 r is accomplished by employing three—and sometimes four—portals of entry. In the majority of cases blood transfusions have been given following irradiation and preparatory to operation. In all but one case of this series of cortical tumors there

THE TRACHEA

Tracheal Diverticulum Observations on a Cadaver and Results of Histologic Study Edward F Ziegelman Arch Otolaryngol, April, 1935, 21, 414-425 (Reprinted by permission from British Med Jour, July 13, 1935, p 7, Epitome of Current Medical Literature)

The author discusses the literature on the rather rare condition of tracheal diverticulosis, and reports observations on a cadaver and the results of histological study. In the acquired type of this condition infection of the mucous glands of the post-tracheal wall appears to be an antecedent factor, the exciting cause is probably some increase in the intratracheal pressure of air. Such a lesion will disturb the laryngeal innervation and cause changes in the voice. It serves as a potential reservoir of infection, continually bathing the lower respiratory tract with purulent material, and endangering the lungs, in which abscess development may ensue. It has to be differentiated from an esophageal diverticulum and a tracheal retention cyst. This may be effected by a radiographic examination of the trachea after the instillation of iodine in poppy-seed oil. The treatment is the surgical removal by amputation or inversion, with any necessary regulation of the patient's occupation. The safety precaution of the two-stage technic, as used in cases of esophageal diverticulum, would seem logical, or the one stage method with the added use of the tracheoscope might be applicable.

TUBERCULOSIS, PULMONARY

The Roentgen Manifestations of the Initial Tuberculous Infiltrate H Assmann Fortschr a d Geb d Röntgenstrahlen, 1935, 51, 1-7

This is a résumé of the knowledge regarding the initial tuberculous infiltrates on the basis of German, French, and American studies. Their roentgen manifestations are apparent as more or less circumscribed, at times somewhat indefinitely delineated, rounded foci or diffuse opacities of even density. Preferred sites commonly are the infraclavicular posterior area of the upper lobes and also the apices of the lower lobes which latter locations are often and easily confused with hilar tuberculous lymph adenopathies. Extensions, particularly of diffuse infiltrations occur predominantly in segments of poor pulmonary ventilation and slow lymphatic exchange and at margins of lobes especially posterior and the lower layers of the upper apices of the lower lobes.

The fate of these initial infiltrates varies greatly—resorption in relatively short periods induration with connective tissue proliferation and scar formation, a contiguous extension, bronchial or vascular dissemination with the well known complications.

Pathologically, the initial infiltrate represents a bronchopneumonic focus with a tendency to central caseation. Clinically the infection may often be masked as a febrile, influenza like attack or else take a more insidious course.

Quite similar roentgen symptoms may be produced by various other diseases, for instance, primary and secondary tumors, abscesses and infarcts, influenza and non-tuberculous bronchopneumonias, rarely syphilis and actinomycosis. Therefore a single roentgen examination cannot give an etiologic differential diagnosis but it should reveal pathologic conditions which frequently escape observation by any other clinical method at a time when rational treatment is most hopeful. All clinical resources should be called on for diagnostic and therapeutic aid, as soon as roentgen studies have revealed a questionable lesion, and frequent roentgen re-examinations are essential.

H A JARRE, M D

Roentgenologic Differential Diagnosis of Miliary Tuberculosis S Scheidegger Fortschr a d Geb d Röntgenstrahlen, 1935, 51, 209-214

A case of miliary non-tuberculous bronchopneumonia, partly chronic in character, partly recent, in the presence of uremia and a hemorrhagic enterocolitis with multiple small necroses in the liver, furnished a roentgenogram somewhat similar to miliary pulmonary tuberculosis. This leads to a brief discussion of the disease processes which at times can simulate the roentgenographic appearance of miliary tuberculosis: passive congestion and edema, bronchopneumonia, especially in influenza, measles, whooping cough, and sepsis, psittacosis, lymphogranulomatosis, Niemann-Pick's disease, carcinomatosis and chorionepithelioma, pneumoconiosis, and bronchiolitis obliterans.

H A JARRE, M D

Significance of Pyrexia in Chronic Pulmonary Tuberculosis Maurice Myers British Med Jour, Aug 10, 1935, 2, 250-252

Before the value of serial x ray films was demonstrated in the treatment of pulmonary tuberculosis, the temperature chart occupied the most prominent place as the indicator of the activity of the disease. However, with the advent of serial x-ray examination, it was noted that it is possible for the disease to be active and spread without any disturbance of the temperature curve and, conversely, that the patient can be febrile over comparatively long periods of time without any evidence that the disease in the lung is spreading. 'Nowadays, the serial x ray examination is undoubtedly the most accurate single method of determining the progress of retrogression of the disease.' However, the author believes that the temperature chart is still of great significance, especially when correlated with serial x ray examination.

The author correlated the temperature curves with the various types of lesions as suggested by Wingfield's classification. The lesions are classified as follows: (1) the secondary lesion consisting of a local allergic reaction due to a deposit of bacilli, (2) the inter-

fiedly identified, and that the interpretation of all roentgenograms should be made by properly qualified medical roentgenologists and by no others

S M ATKINS, M D

THE SKIN

Radium Dosage and Technique in Benign Lesions of the Skin Howard Morrow and Laurence R Taussig *Am Jour Roentgenol and Rad Ther*, December, 1934, 32, 735-737

In most benign dermatologic conditions in which radiation therapy is indicated roentgen rays are superior to radium. The notable exceptions are the vascular birth marks. In the cavernous hemangiomas, radium is by far the best method of treatment while in nevus vasculosus it has certain important points of superiority over any other form of treatment

S M ATKINS, M D

THE SPINE

The Prognosis of Fractures of the Vertebrae E Walter Hall *Am Jour Roentgenol and Rad Ther*, November, 1934 32, 617-621

Studying 155 consecutive cases of vertebral fractures, the conclusions were drawn that in the majority of cases, namely, those with little or no vertebral deformity, no narrowing of the discs, or with fixation by bony ankylosis approximating 70 per cent of all vertebral body fractures the ultimate prognosis should be good both for recovery of function and freedom from symptoms

With the newer methods of treatment namely, complete reduction in marked hyperextension, application of a cast in this position, and institution of physiotherapy and exercise the percentage of freedom from symptoms should be materially increased. Fixation in the cast for from three to five months is advised by Jimeno-Vidal, and no further support after that

Herniation of the nucleus pulposus has been overemphasized, for many instances of the condition are seen in patients who have no symptoms

Fractures of the transverse processes are not rare and heal as readily as fractured ribs and should be treated in the same fashion—adhesive strapping and not a plaster cast. Patients should be symptom free and able to resume normal activities in from two to three months

S M ATKINS, M D

THE STOMACH

Wrong Diagnosis in the Roentgen Diagnosis of the Stomach Fritz Cisler *Röntgenpraxis*, July, 1935, 7, 447-455

Too many failures in the diagnosis of gastric lesions can be attributed to wrong or lax technique (food in the stomach, neglect to take enough roentgenograms or to

use a special technique). These errors are avoidable while errors of judgment are sometimes not avoidable.

In an ulcer a niche might be present at one time and absent a few hours afterward to be explained by a filling of the ulcer with mucus food or blood. Occasionally suspicious cases therefore, must be re-examined if one examination is negative. A niche in the cardiac portion is easy to overlook especially in a cascade stomach. In the pyloric and prepyloric portions of the stomach, niches may not be shown due to hypersecretion or obstruction. In such cases it is advisable to refrain from a pathologic diagnosis (ulcer, cancer, scar, etc.) and to call attention only to an obstructing lesion. Marked hypertrophy of the gastric mucosa might obscure a small niche. The size of the niche cannot be used as a criterion for healing in all cases. Secretion swelling of the mucosa projection etc., may be responsible for apparent changes

Carcinomas of the fundus are often missed. The reason is poor visualization and impossibility of palpation. Examination of the stomach after artificial filling with gas is quite important in such cases. In the pyloric region it is often impossible to differentiate between ulcer and early cancer

It is occasionally difficult to state, from a roentgenologic standpoint if cancer is present or only hypertrophied mucosa

Diaphragmatic hernias, especially of the hiatus type, are quite often missed because they are not looked for

With the tremendous advance of roentgenologic diagnosis of the stomach mistakes are still possible

HANS W HEFKE, M D

SYRINGOMYELIA

Syringomyelia Its Roentgenologic Diagnosis and Radiotherapeutic Response E A Zimmer *Fortschr a d Geb d Röntgenstrahlen* 1935, 51, 247-260

This paper presents a brief review of the pathology, roentgen diagnosis and therapy of syringomyelia. Hydromyelia is separated from syringomyelia as it corresponds to hydrocephalus internus and represents congenital or acquired distention of the central canal and filling with hydropic fluid. Pyo or hematomyelia occurs. The roentgenologic and pathologic anatomical review of cases afflicted with this disease may distinguish between atrophic and hypertrophic articular manifestations. Malignant tumors and Charcot joints may at times be confused with syringomyelia. Various surgeons have attempted improvement of the condition by opening and drainage of the cyst in the spinal cord responsible for the neurologic disturbance with but limited results

Radiation therapy proved beneficial in a large majority of patients subjected to this treatment. In the author's institution approximately 50 per cent of a single erythema dose is delivered to the spinal cord for therapeutic purposes. Radiation treatment of this disease should be encouraged

H A JARRE M D

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A STUDY OF THE ROENTGENOLOGIC APPEARANCE OF THE LOBES OF THE LUNG AND THE INTERLOBAR FISSURES¹

By JOSEPH LEVITIN, M D , and HAROLD BRUNN, M D , *San Francisco*

From the Department of Roentgenology, Mt Zion Hospital,
and the University of California Thoracic Clinic

ROENTGENOGRAMS consist of superimposed shadows of a three-dimension object projected on a flat plane. The shadows obtained on the film are of two dimensions and do not give a true picture of the shape of the process or its location. To bring out the third dimension, stereo-roentgenograms are often taken. The use of postero-anterior and lateral projections gives us two films in planes at right-angles to each other, which is of great aid in studying the position and shape of the parts under consideration.²

The necessity of knowing the exact position and shape of a disease process is especially important in the chest. Processes occurring in the interlobar septa offer particular difficulty in interpretation on a single postero-anterior projection. Because of the oblique position of the septa, the horizontal ray projects the shadow of the septa on the roentgenogram as a broad surface, giving the impression of a diffuse area of lung involvement. Stereo-roentgenograms do not bring out the true nature or location of this process. A lateral view, in the same plane as the interlobar fissure, gives us a totally different conception as to the limits of the process.

No longer should roentgenologists be satisfied to make a diagnosis of shadows of increased density occupying the upper or lower part of the chest. With the demand for information made by the chest surgeon, roentgenologists are called upon to be more accurate in locating the disease process, as well as to be more specific regarding its nature.

Considerable literature has appeared concerning the roentgenologic appearance of certain disease processes, but there is no satisfactory study available as a guide to the exact appearance on the roentgenogram of the lobes of the lung and the interlobar septa.

This study was undertaken to provide such a set of diagrams, showing the appearance of the lobes of the lung and interlobar septa in the postero-anterior and lateral views. The shadows obtained were subsequently compared to clinical cases of unquestioned diagnoses. We do not mean to imply that all disease processes affecting these divisions of the lung would occupy the areas designated in the diagrams. Previous disease conditions of the lung may have resulted in retraction, distortion, or displacement of the region of the lung under consideration. The entire interlobar septum may not be, and usually is not, involved by the disease process. Likewise, only a portion of one or more

¹ Supported by the Lily Spreckels Weggeforth Fund

² The reader will observe that the illustrations in this paper do not occur in numerical order. This is due to the unusual number and large size of the illustrations coupled with the terse style of the text.

mediate lesion corresponding to what is known as active fibro-caseous disease, (3) the tertiary lesion, which corresponds to the healed, non progressive intermediate lesion

It was noted that the small "secondary" lesion about the size of a two shilling piece may produce no symptoms. The medium sized "secondary" lesion results in a disturbance of temperature somewhat similar to a mild attack of influenza, which may return to normal in a few days and remain normal for many weeks or months. The large 'secondary' lesion has an onset somewhat more marked than the medium sized lesion and resembles an attack of lobar pneumonia. However, the temperature returns to normal gradually by lysis after a period of about 14 days. The absence of tubercle bacilli in the sputum and the absence of the crisis distinguishes this from lobar pneumonia.

It was observed in the case of the 'intermediate' lesion that the disease may be active and spreading and still give no indication on the temperature chart for the first few weeks. It is believed that temperature and clinical symptoms are noted in this condition only with the erosion of a patent bronchus and the onset of secondary infection. During the period that a patient is pyrexial as a result of a spreading 'intermediate' lesion infected with pyogenic organisms it is still possible for a new 'secondary' lesion to appear in the lungs.

While the 'tertiary' lesion theoretically should not be associated with pyrexia this is not always the case, for many patients with static lesions who appear to be in good general health run a constant mild pyrexia which is considered of little significance. The increased temperature in these cases is believed due to the secondary infection in the small cavities and to alteration in the temperature control mechanism which has occurred as a result of prolonged pyrexia and toxemia.

Another temperature chart of importance is that due to 'late cavitation'. This may occur in a case that has

had a fairly gross disease followed by massive fibrosis. In the course of a mild intercurrent respiratory tract infection, the patient may exhibit a few days of mild pyrexia followed by a marked rise in temperature associated with the expectoration of a large amount of purulent material. The temperature then falls rapidly to normal or to a state of mild pyrexia. The x ray film in these cases shows cavitation of an old fibrosed lesion with no spread of the disease. This cavitation results from secondary infection of the old caseous material.

J. N. ANÉ M.D.

VASOMOTOR DISTURBANCES

Röntgen Therapy in Vasomotor Disturbances of the Extremities. R. Gilbert and L. Babaianz. *Strahlen therapie* 1935, 53, 455-472.

The following affections belonging to the group of vasomotor disturbances were treated by roentgen rays: *intermittent claudication, paresthesia, erythromelalgia, Raynaud's disease, endarteritis obliterans, Burger's disease, trophic ulcers* and post traumatic circulatory disturbances. It is possible to irradiate the sympathetic nervous system alone or combine it with exposures of the adrenals. **Technic:** Moderate voltage, filter 2-5 mm. Al for the periphery and 0.5 mm. Cu for the deeper seated sympathetic nerves, 500-800 r distributed over from 2 to 3 weeks, dose per sitting and per field 175 r. Of the 11 cases treated, five showed excellent response and brief histories of these are appended. The remaining six either did not respond or could not be followed up or had been treated too recently to allow of the drawing of any definite conclusions. Several photographs of the lesions before and after therapy also accompany the article. As supplementary treatment, medication and diathermy may be considered.

ERNST A. POHLE M.D., Ph.D.



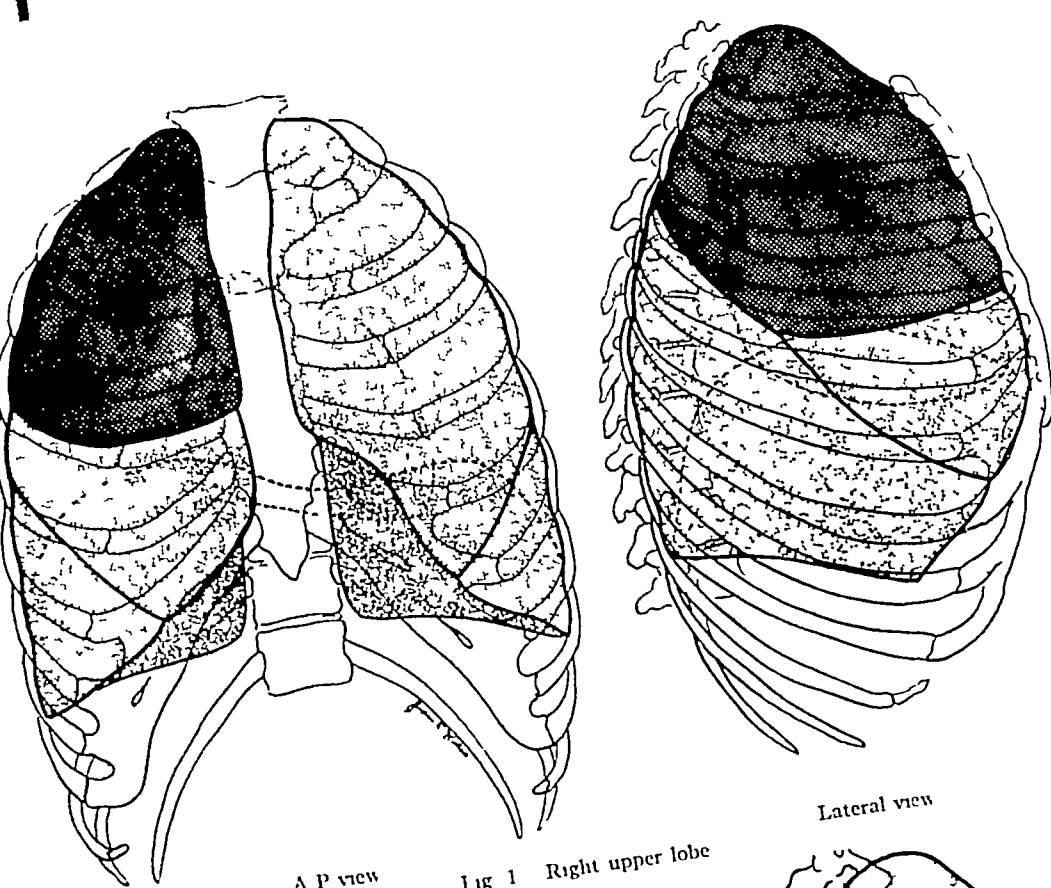
Fig 1-A Case 1 Pneumonic consolidation of the right upper lobe

lobes may be affected. Notwithstanding such factors which may play a part in the distortion of these shadows, the general configuration of the affected parts of the

lung closely simulate the diagrams experimentally produced.

In a previous article³ one of us described

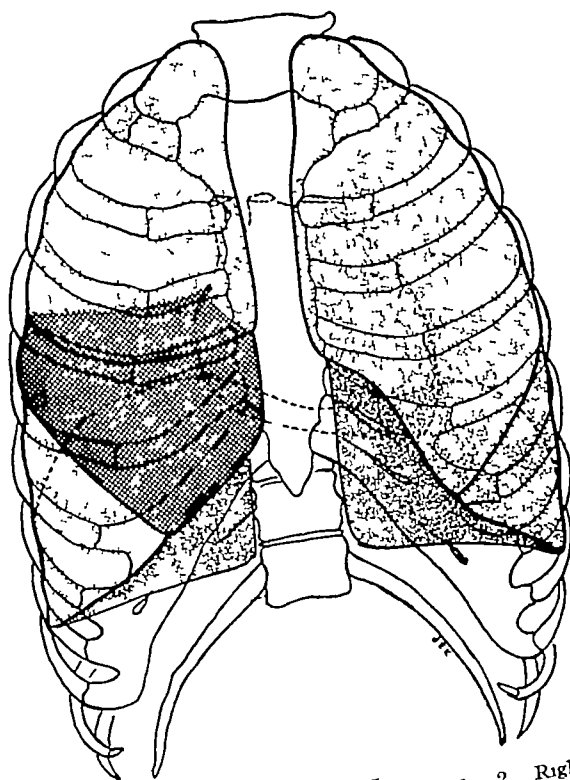
³ RADIOLOGY, November 1934, 23, 629-634



A P view

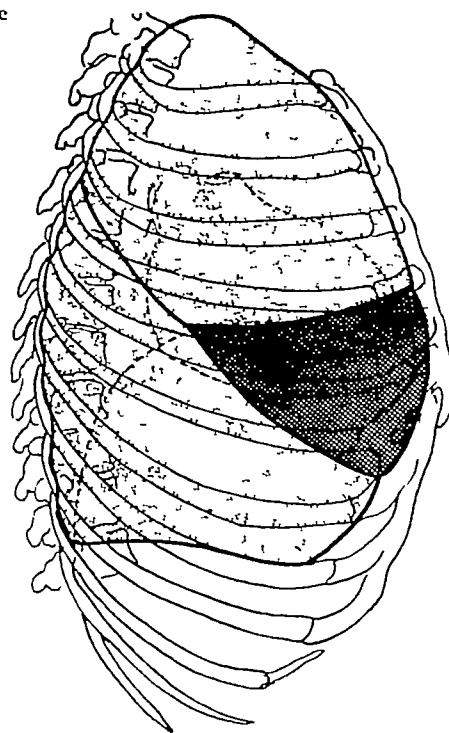
Fig 1 Right upper lobe

Lateral view

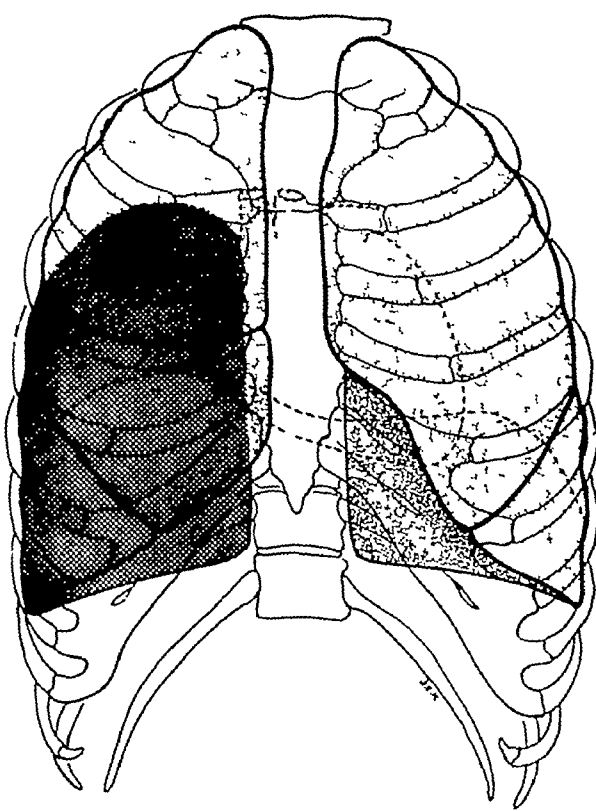


A P view

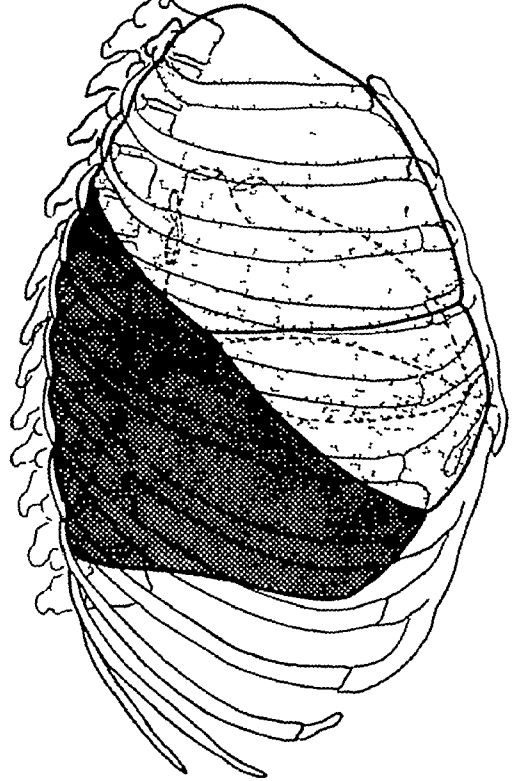
Fig 2 Right middle lobe



Lateral view

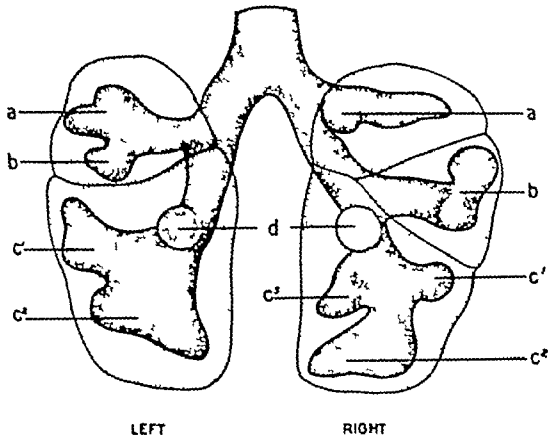


A-P view



Lateral view

Fig 3 Right lower lobe



LEFT

RIGHT

Fig 4 Human embryo (11 mm)

a b Anlage for bronchi to single left upper lobes

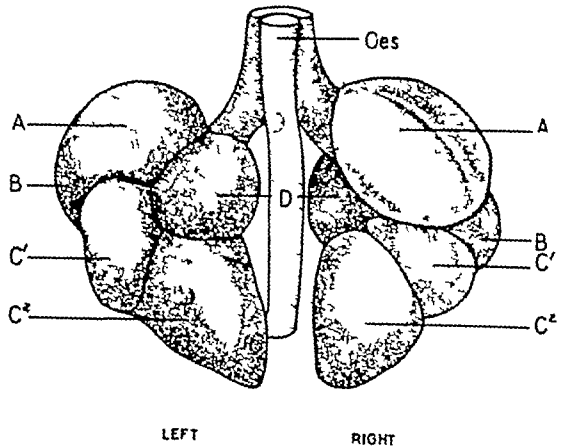
c¹, c² Main bronchial anlage for left lower lobe

d Separate origin of bronchial anlage for superior division of lower lobe

a Anlage of apical bronchus for right upper lobe

b Anlage of lateral first central bronchus for right middle lobe

c¹ c² c³ Main bronchial anlage for right lower lobe



LEFT

RIGHT

Fig 5 Human embryo (13 mm) Development of lung buds

A, B Lung buds for single left upper lobe

C¹ C² Lung buds for inferior division of left lower lobe

D, Lung bud for superior division of left lower lobe

A, Lung bud for right upper lobe

B, Lung bud for right middle lobe

C¹ C², Lung buds for inferior division of right lower lobe

D, Lung bud for superior division of right lower lobe Failure of fusion of lung bud *D* with lung buds *C¹, C²* accounts for the presence of an anomalous fissure in the developed lung

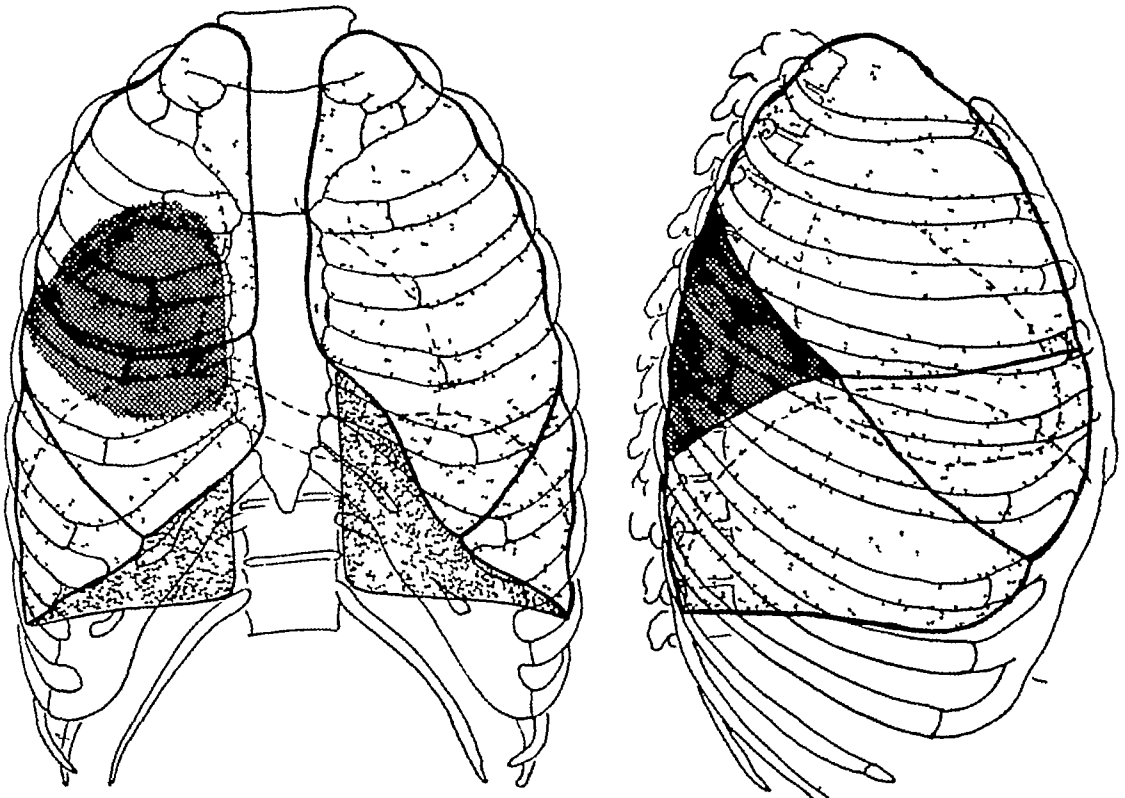


Fig 2 A Case 2 Pneumonic consolidation of the right middle lobe Note clearance at lateral margin of the base the area occupied by the lower lobe If the diaphragm is elevated the shadow of the middle lobe is continuous with that of the liver

the roentgenologic appearance of the potential interlobar spaces The present study is a continuation of the subject, illustrating the affected spaces by clinical cases

In addition, we have included a study of the appearance of the various lobes of the lung, with illustrative cases

Method—Models of the lobes were made



A P view

Lat view

Fig 6 Superior division of right lower lobe

pearance of each interlobar fissure was studied by placing the lead foil between the lobes and taking the films in the postero-anterior and lateral positions. Because of artefacts in the preparation of the skeleton, the roentgenograms obtained were subsequently diagrammed. In the prepared diagrams the position of the heart was indicated by dotted lines. The fissures of the surface of the lung as seen on the frontal and lateral surfaces were indicated by a heavy black line. The interlobar fissure studied was indicated by a heavy checkered shadow. A high diaphragm adds to the difficulty of interpretation. At full expiration the diaphragm rises to a height on a plane with the level of the lower border of the fourth rib,

thus masking a considerable portion of the lung. The diaphragm was indicated on the diagrams at full expiration.

We have found these diagrams of great aid in the interpretation of many obscure shadows. At this point we wish to emphasize again the importance of a comparative study of the lateral and postero-anterior projections in arriving at conclusions as to the location of processes in the chest.

GENERAL DESCRIPTION OF THE LOBES AND INTERLOBAR FISSURES

The right lung is divided into three lobes—upper, middle, and lower—by two interlobar fissures, and the left lung is divided into two lobes—upper and lower—

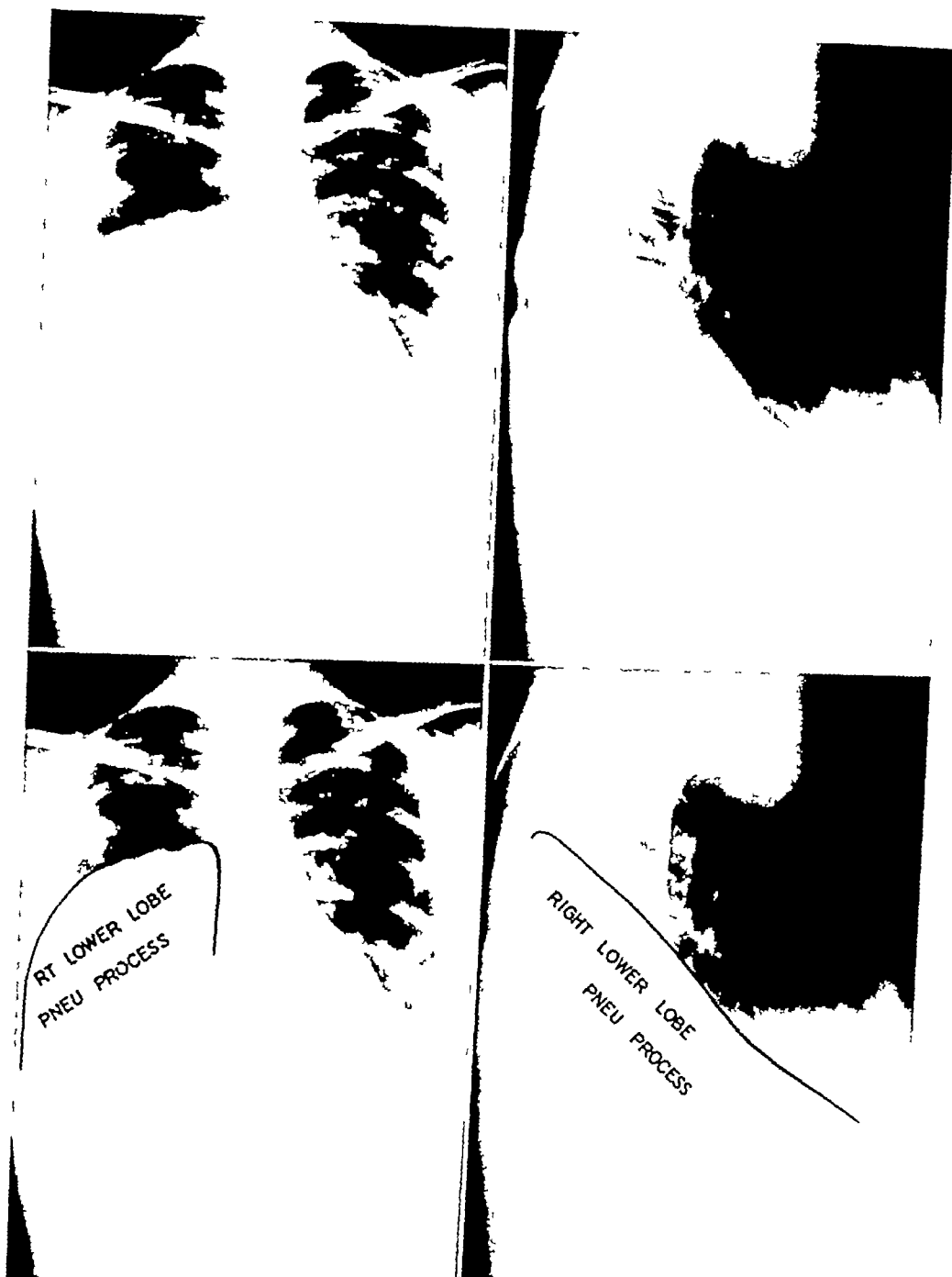
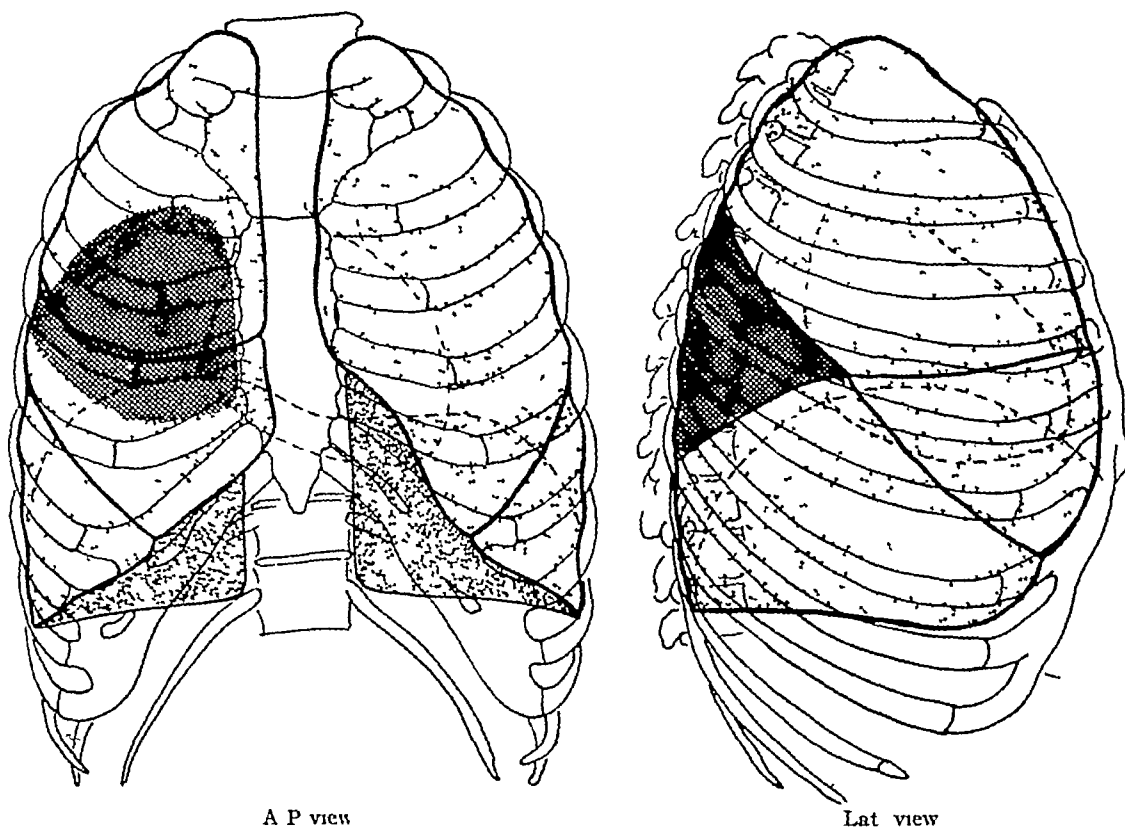


Fig 3 A Case 3 Lobar pneumonia of the right lower lobe Confirmed at autopsy

of paraffin, which is transparent to the x-ray. The models were fitted into a thoracic skeleton. To study the appearance and location of the individual lobe, lead

foil about one-fourth millimeter in thickness was wrapped around the various lobes and films were taken in the postero-anterior and lateral positions. The ap-



A P view

Lat view

Fig 6 Superior division of right lower lobe

pearance of each interlobar fissure was studied by placing the lead foil between the lobes and taking the films in the postero-anterior and lateral positions. Because of artefacts in the preparation of the skeleton, the roentgenograms obtained were subsequently diagrammed. In the prepared diagrams the position of the heart was indicated by dotted lines. The fissures of the surface of the lung as seen on the frontal and lateral surfaces were indicated by a heavy black line. The interlobar fissure studied was indicated by a heavy checkered shadow. A high diaphragm adds to the difficulty of interpretation. At full expiration the diaphragm rises to a height on a plane with the level of the lower border of the fourth rib,

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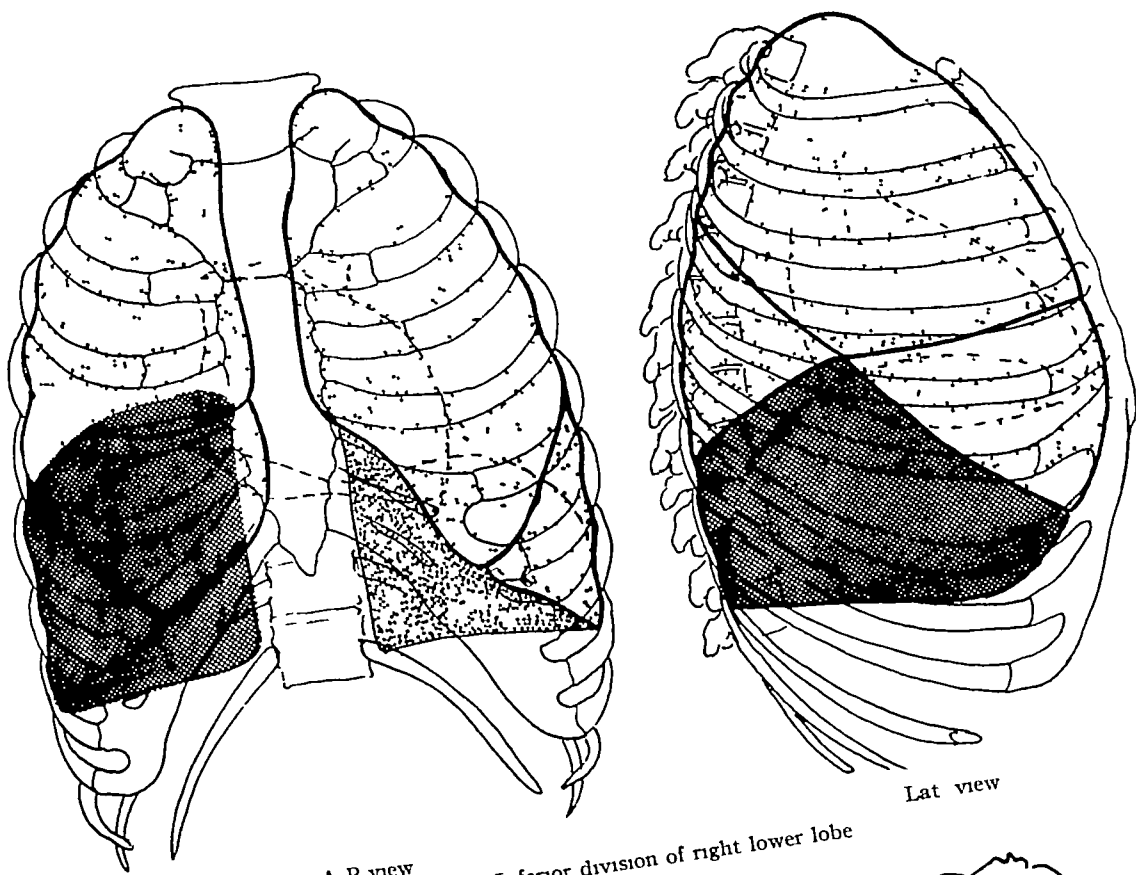
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GENERAL DESCRIPTION OF THE LOBES AND INTERLOBAR FISSURES

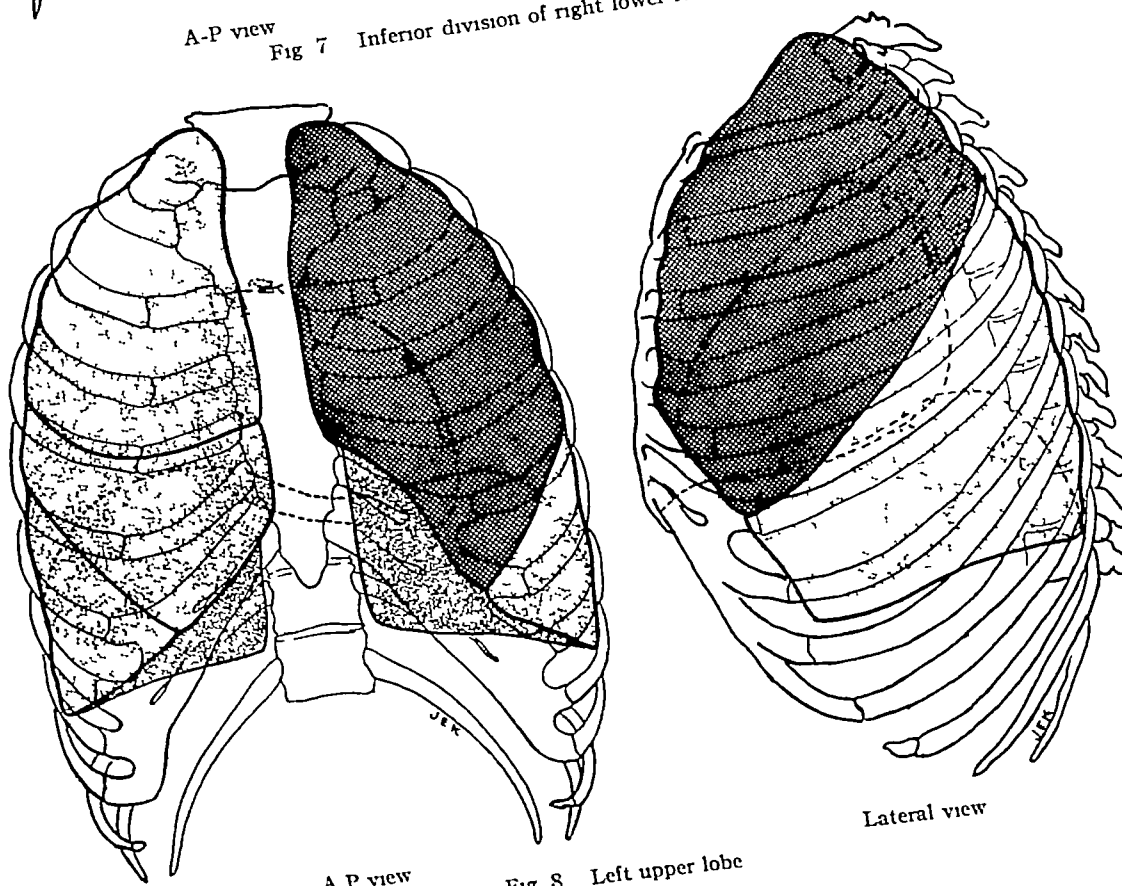
The right lung is divided into three lobes—upper, middle, and lower—by two interlobar fissures, and the left lung is divided into two lobes—upper and lower—



Fig 6-A Case 4 Pneumonic process superior division of the right lower lobe which developed into a lung abscess. Note the posterior triangular appearance of this process in the lateral view.



A-P view
Fig 7 Inferior division of right lower lobe



A P view
Fig 8 Left upper lobe

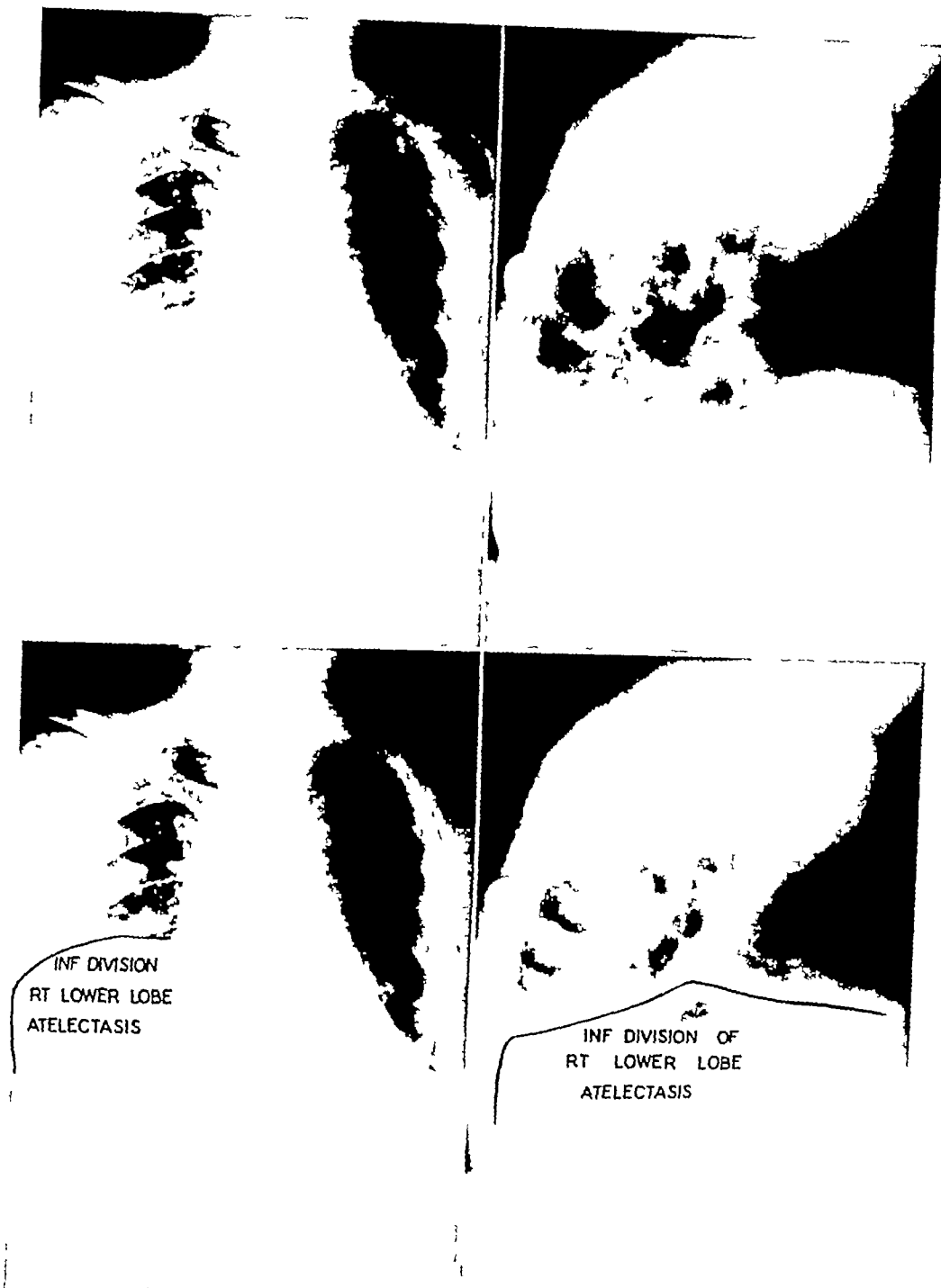
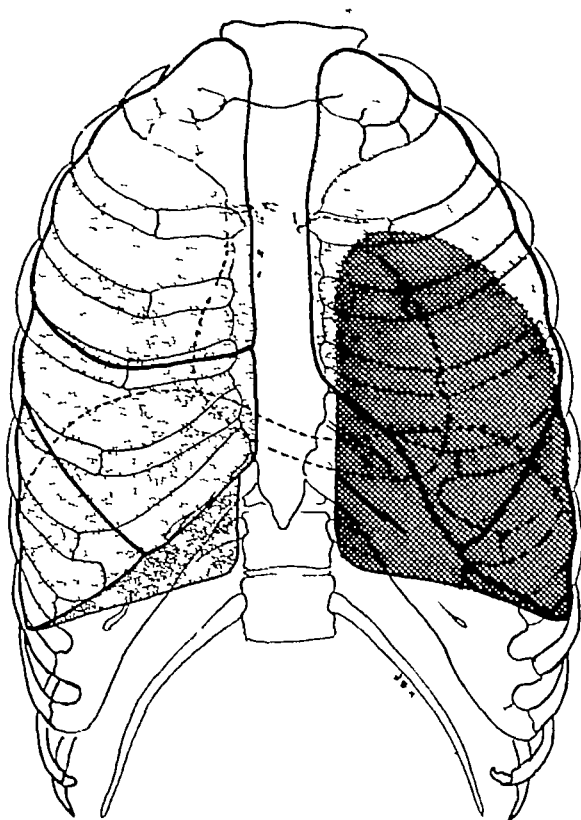
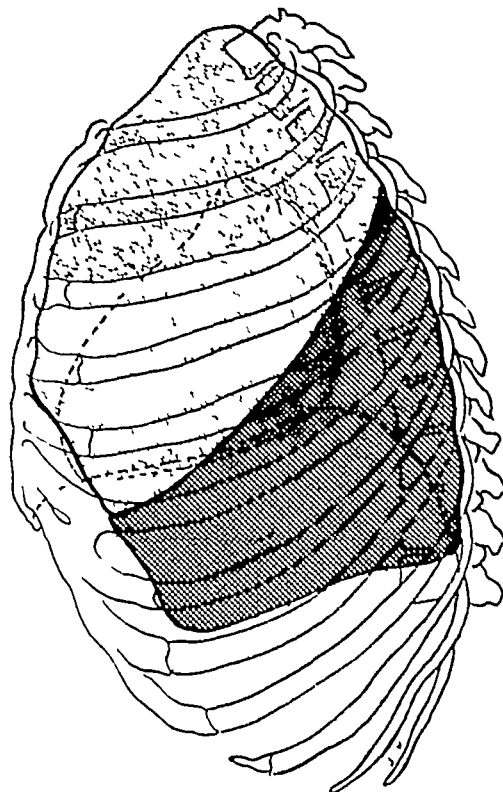


Fig 7 A Case 5 Atelectasis of inferior division of the right lower lobe as result of carcinoma of the bronchus The shadow of this part of the lobe is continuous with the liver shadow and in the lateral view the posterior recess behind the diaphragm is obscured by this part of the involved lung



A-P view



Lateral view

Fig 9 Left lower lobe

by one interlobar fissure. The course of the major fissure on both sides is from the level of the spinous process of the third dorsal vertebra posteriorly, obliquely downward and forward to the costochondral articulation of the sixth rib anteriorly. It separates the superior lobe above and the inferior lobe below. On the right side another fissure extends horizontally forward from the axilla to the costochondral articulation of the fourth rib. It divides the superior lobe into an upper and a middle lobe.

THE LOBES OF THE LUNG

Right Upper Lobe (Fig 1)—The right upper is the superior lobe and on the roentgenogram occupies most of the chest in the postero-anterior view. The shadow of the diaphragm at full expiration extends almost to the shadow of the lower margin of this lobe. The lateral view shows the lobe filling the upper chest, corresponding

closely to the rib cage. From the hilus the lower border extends forward horizontally to the anterior chest wall and backward obliquely to the posterior chest wall. The upper lobe overlaps the superior part of the lower lobe in the postero-anterior view.

Right Middle Lobe (Fig 2)—The right middle lobe is an anterior lobe, triangular in shape, with the apex at the hilus. In the postero-anterior view it occupies the lower half of the chest. The upper border is horizontal, extending outward from the hilus. The lateral margin curves medially so that a part of the lower lobe is visible at the base in the axilla. However, this part of the lobe is customarily not seen, it is usually obscured by the diaphragm. The lateral view clearly demonstrates the triangular and anterior position of this lobe. In this position, the shadow of the lobe superimposes the cardiac shadow, from which it must be differentiated.

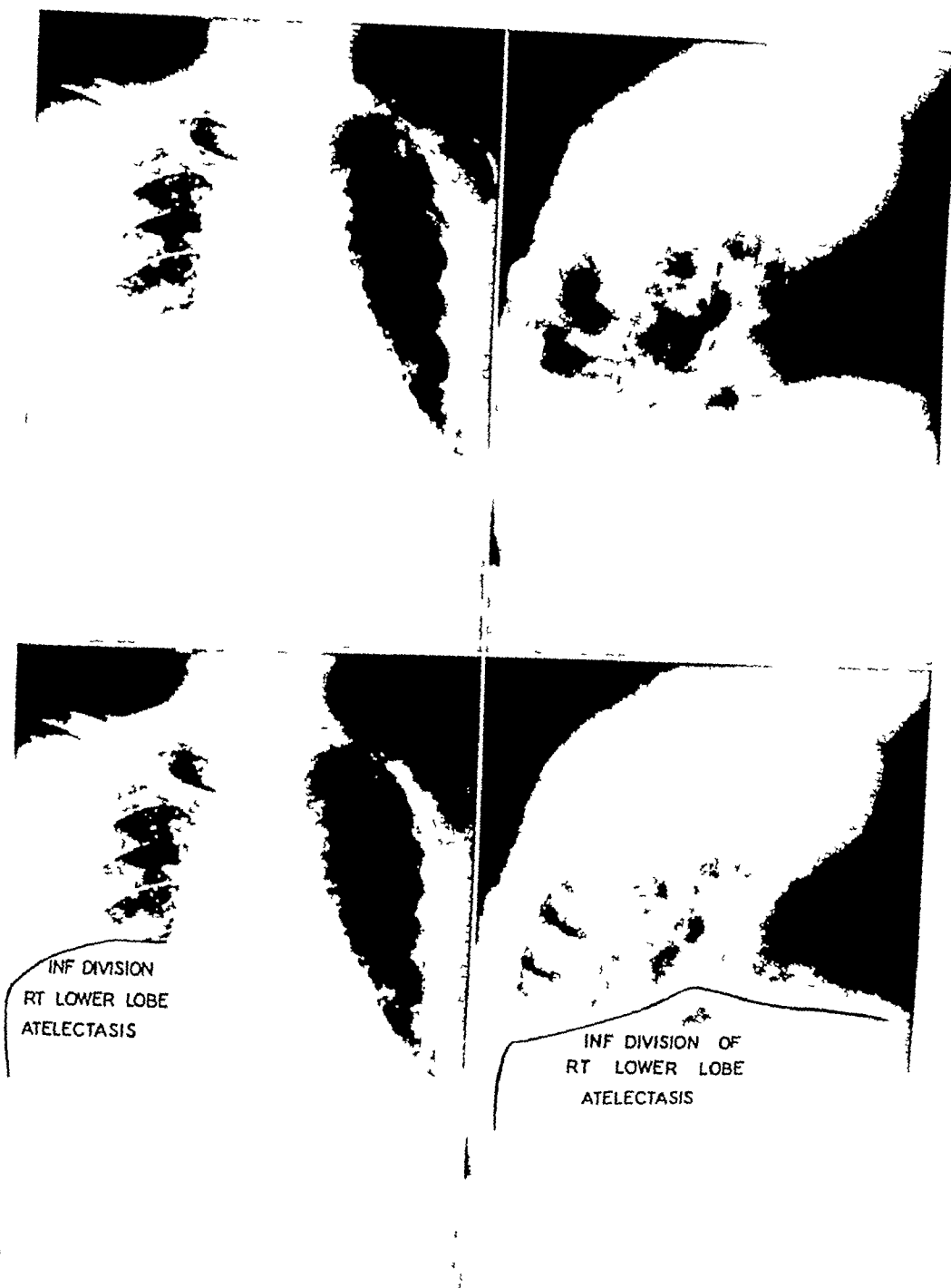


Fig 7 A Case 5 Atelectasis of inferior division of the right lower lobe as result of carcinoma of the bronchus The shadow of this part of the lobe is continuous with the liver shadow and in the lateral view the posterior recess behind the diaphragm is obscured by this part of the involved lung

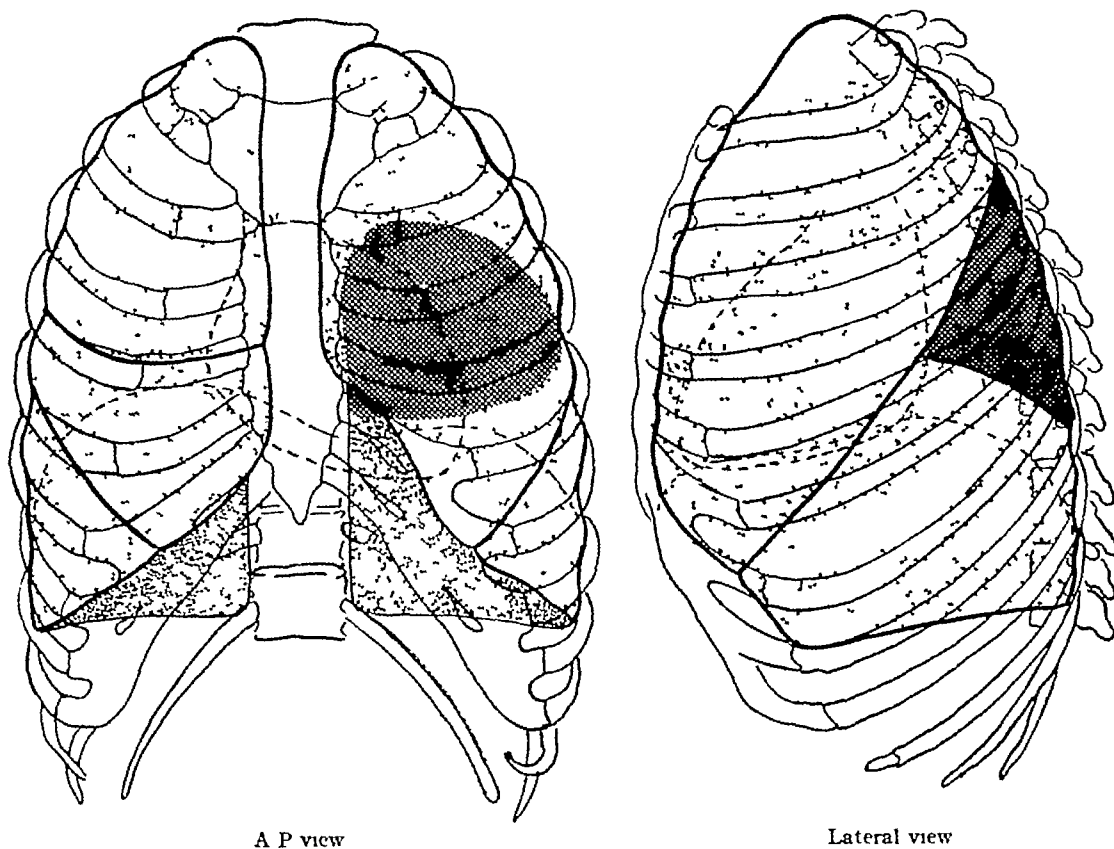


Fig 10 Superior division of left lower lobe

The Right Lower Lobe (Fig 3)—The right lower lobe occupies the posterior and inferior part of the chest. It extends as high as the fourth rib posteriorly, and in the postero-anterior view is projected on a level with the second rib anteriorly. It is found in the axilla and for a small area on the anterior chest wall, where it borders the middle lobe.

In a previous article¹ one of the authors described the lower lobes on either side as divided into two parts, a superior and an inferior division. The division of this lobe has an embryological origin. There is a distinct bronchial distribution to each of its parts and a fissure separating them may be present. Figure 4 demonstrates the separate origin of the bronchial anlage. Figure 5 explains the formation of the fissures between the lobes. Failure of fusion between the separate buds of the lower lobes accounts for the anomalous fissures often present.

Superior Division (Fig 6)—The superior division of the lower lobe is the upper posterior part of the lobe, well seen in the lateral view, occupying a triangular area, with the apex at the hilus. It is that part of the lower lobe which for the most part lies behind the superior lobe. When the diaphragm is low, it appears to occupy the central part of the chest in the postero-anterior view. With an elevated diaphragm its shadow may be continuous with the liver shadow. The lateral view clearly establishes the triangular posterior position. Lung abscesses are most frequently found in this part of the lung. Primary carcinoma of the lung is infrequently found here. Pneumonia of the lower lobe also is more frequent in this part of the lobe, and because of its central appearance on the roentgenogram, is often called "central pneumonia." The physical signs of this process are found in a small circumscribed area posteriorly between the scapula and



Fig 9.4 Case 6 Atelectasis of the left lower lobe as result of primary carcinoma of the main bronchus of the left lower lobe

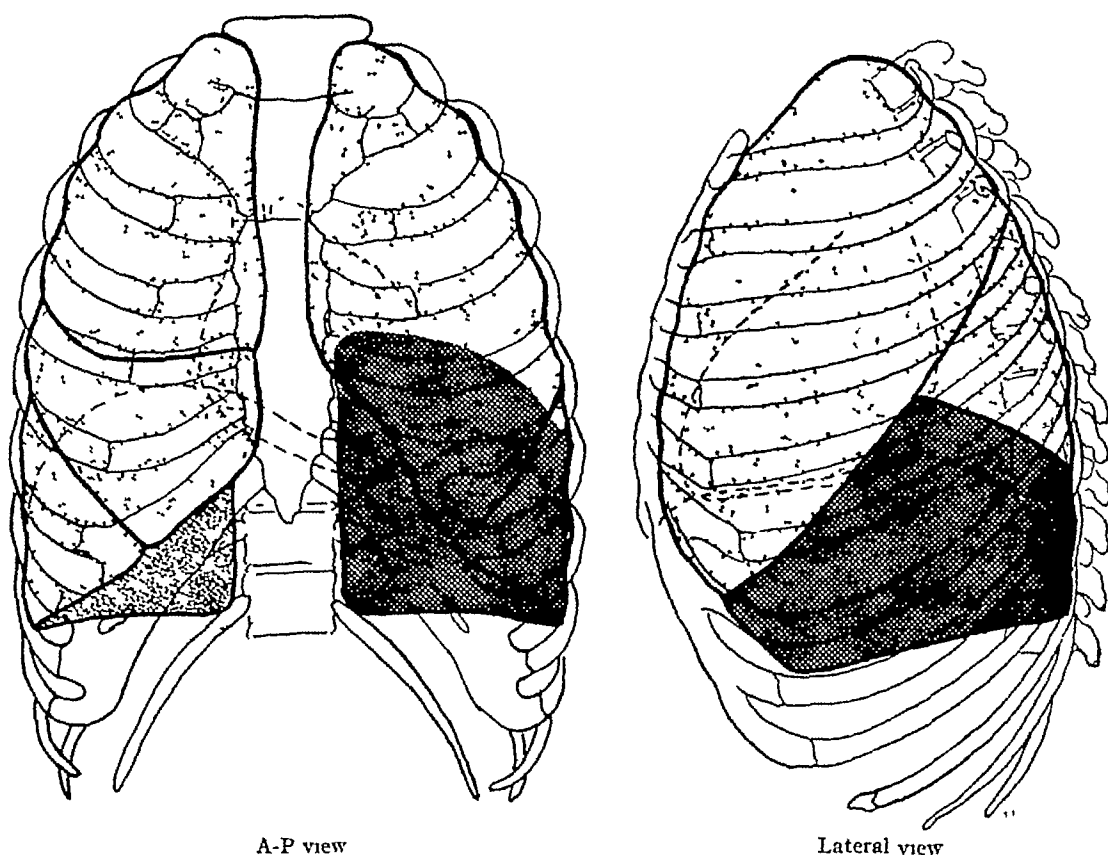


Fig 11 Inferior division of left lower lobe

spine and between the fourth to eighth ribs

Inferior Division of the Lower Lobe (Fig 7)—The inferior division is the larger part of the lower lobe. It extends posteriorly, anteriorly, and down to the diaphragm. Its shadow is continuous with the shadow of the liver. In the postero-anterior view the upper border may be horizontal or oblique, depending on the nature of the disease process, *i e.*, whether consolidated or atelectatic. The upper border in the lateral view is usually tented, although it too may be horizontal, again depending on the nature of the disease process. Atelectasis is frequently found here, especially post-operative. A study of the diagram explains why physical signs of atelectasis of this part of the lung are frequently absent and considerable lung involvement is seen on the roentgenogram. If the atelectasis is of long duration, there is considerable diminution in size of the

involved lung. The superior division of the lower lobe will become emphysematous and fill the posterior recess behind the diaphragm. Normal breath sounds and resonance will be found posteriorly. Likewise, anteriorly, the clear middle lobe will mask the involved lung. There may be a few signs in the axilla. The dullness, if found, is continuous with the liver dullness.

The Left Lung—The left lung does not present as many complicating factors in its appearance on the roentgenogram as does the right lung. The presence of only two lobes, with the one interlobar fissure, reduces the number of possible combinations of lobes involved and interlobar effusions with its superimposed shadows.

It is interesting to note the infrequency of involvement of the entire left upper lobe by pneumonic consolidation and the infrequency of effusion in the interlobar fissure. Of a total of 370 cases of pneumonia, reviewed at Mt Zion Hospital, only

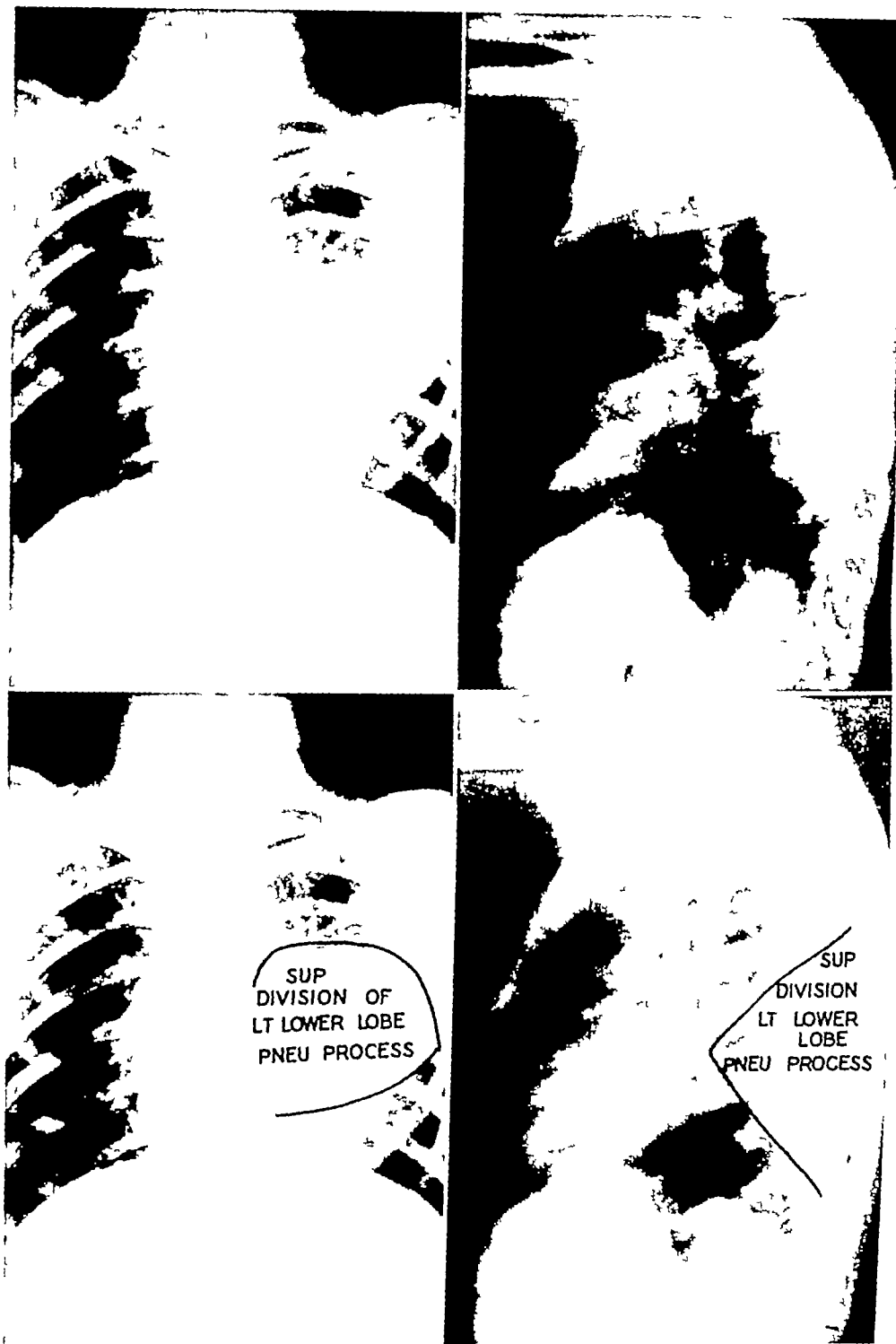
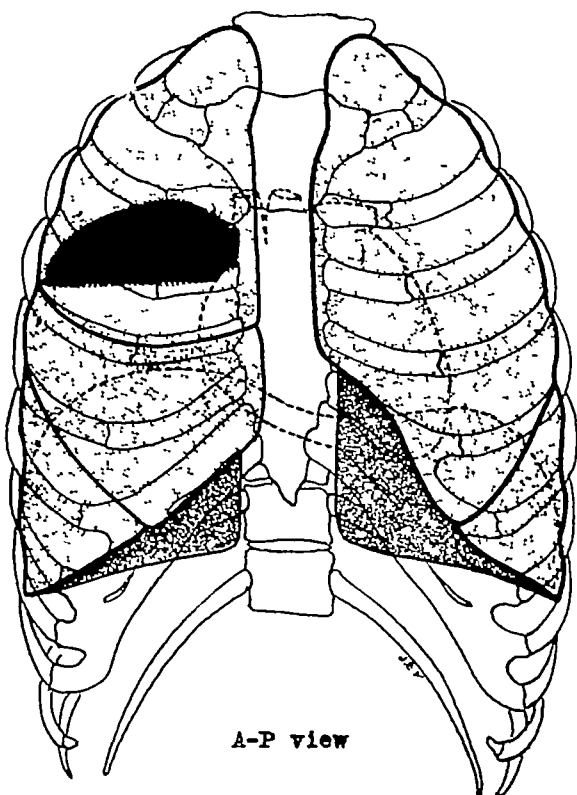
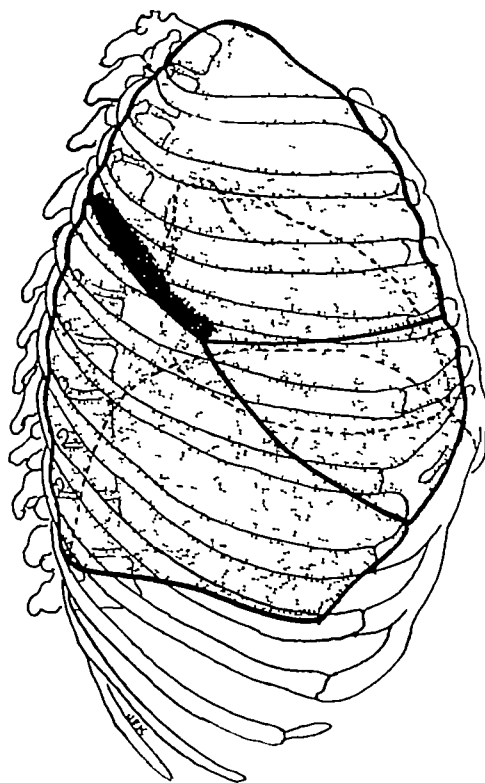


Fig 10 A Case 7 Pneumonia involving the superior division of the left lower lobe.

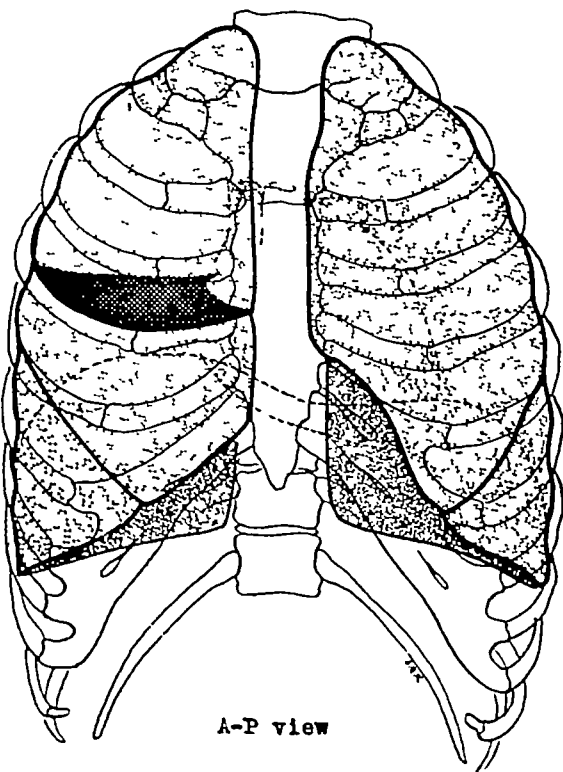


A-P view

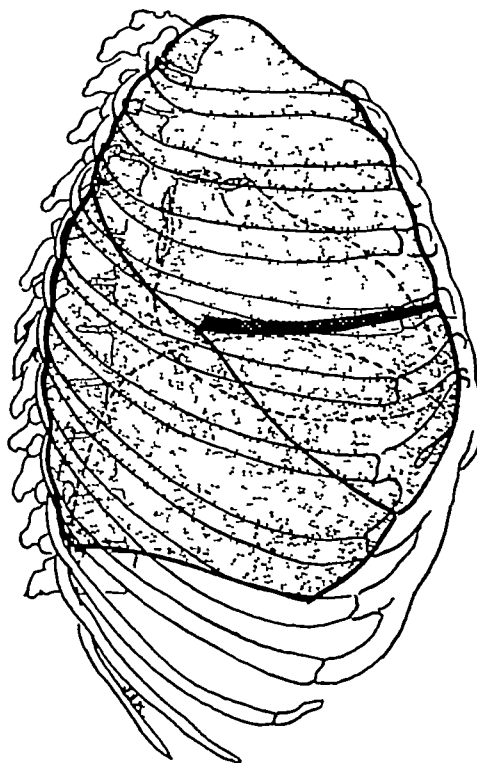


Lateral view

Fig 12 Interlobar fissure between the right upper and right lower lobes



A-P view



Lateral view

Fig 13 Interlobar fissure between the right upper and right middle lobes

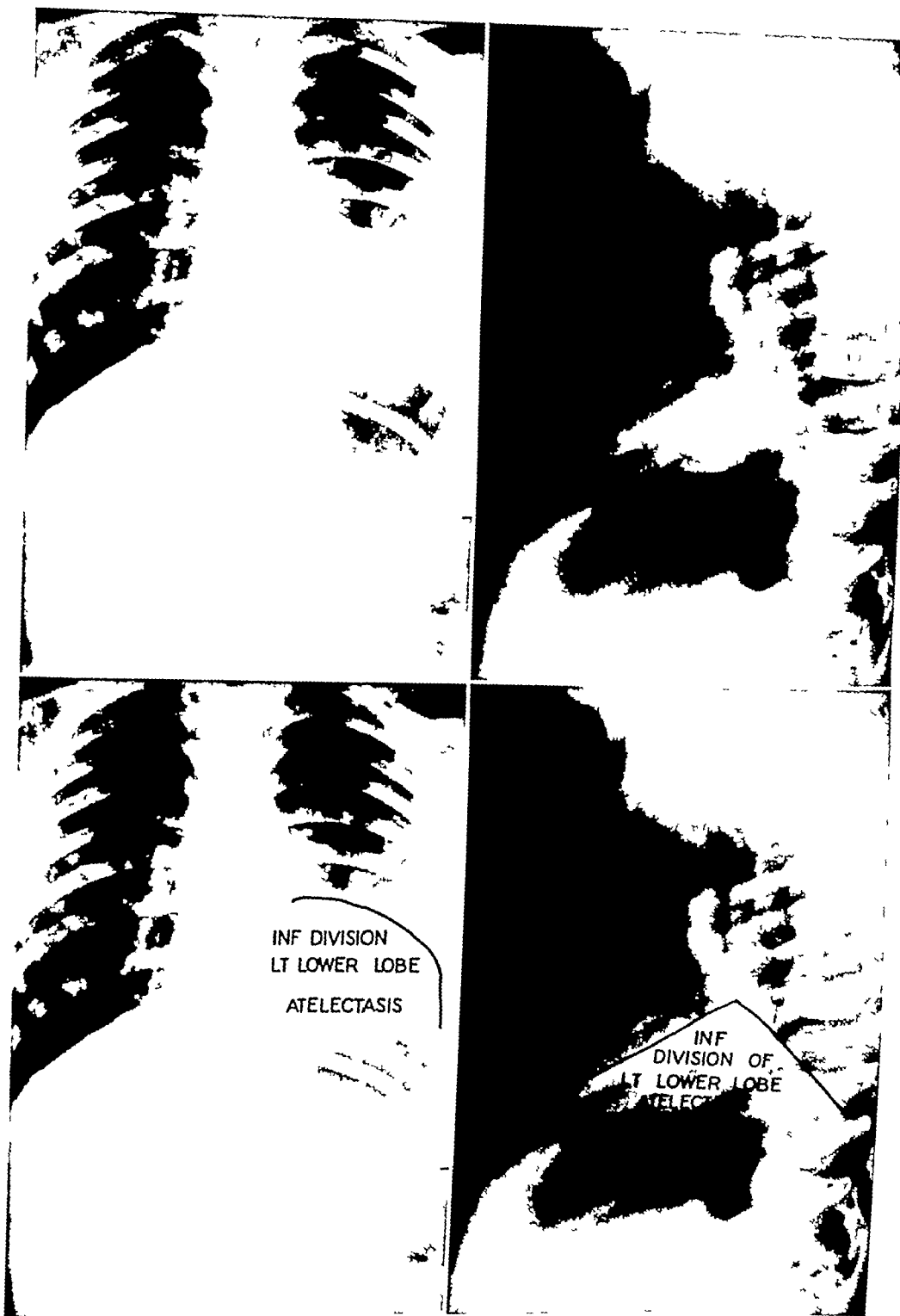
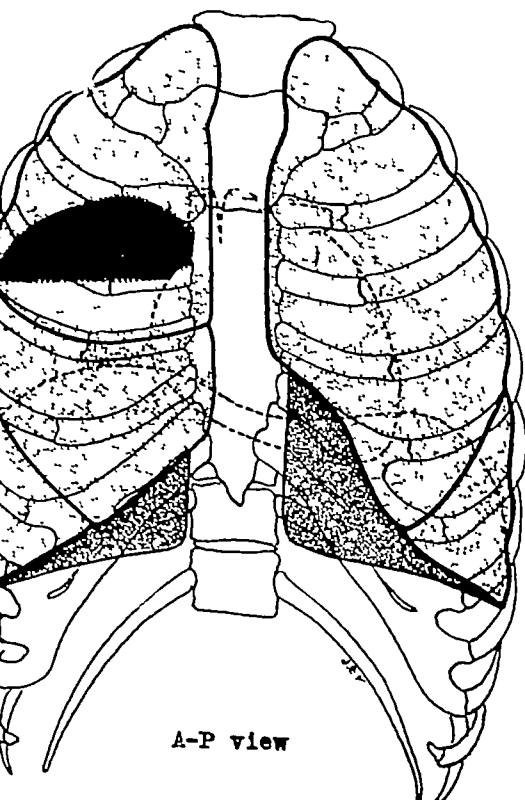
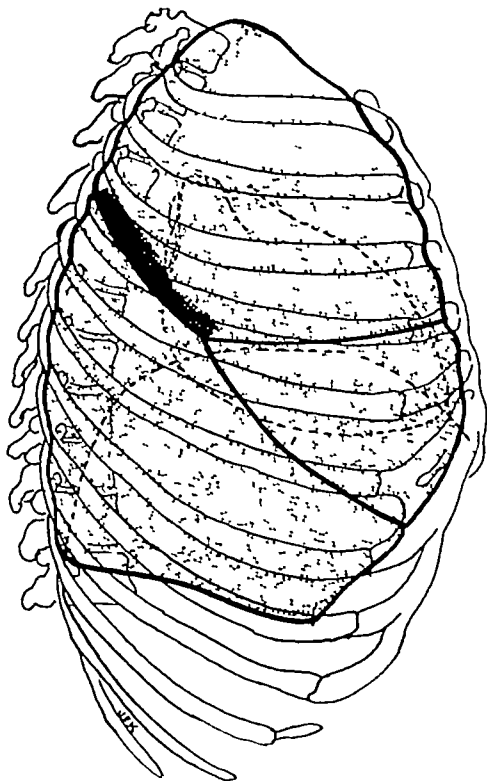


Fig 11 A Case 8 Atelectasis of inferior division of the left lower lobe as the result of a mucous plug The lateral view demonstrates the tented appearance of this part of the lobe The normal lung overlies this process both anteriorly and posteriorly which accounts for the fact that physical examination may not reveal the underlying process

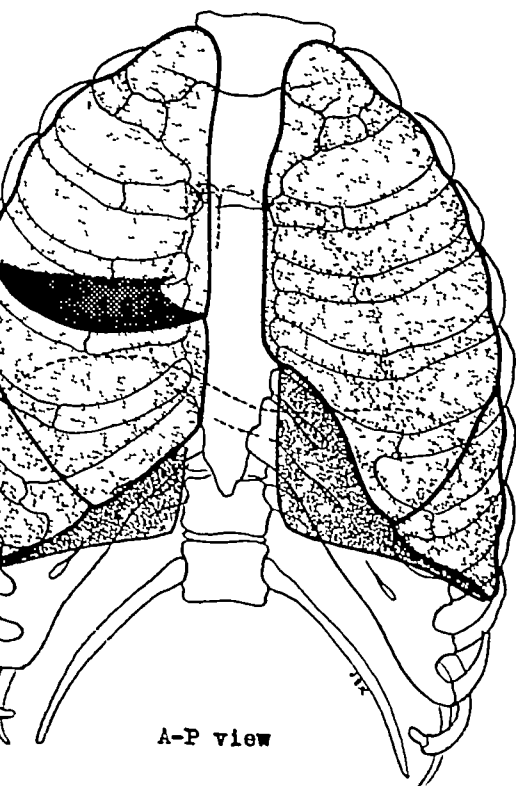


A-P view

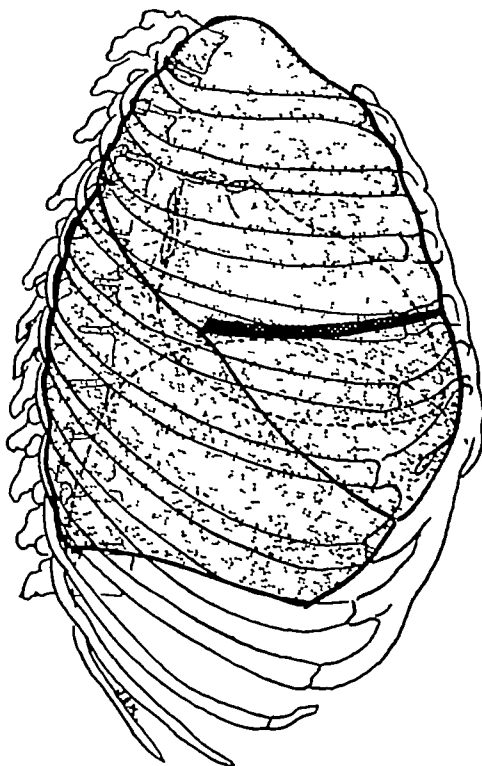


Lateral view

Fig 12 Interlobar fissure between the right upper and right lower lobes



A-P view



Lateral view

Fig 13 Interlobar fissure between the right upper and right middle lobes



Fig 12 A Case 9 Interlobar effusion between the right upper and right lower lobes This was a neighboring effusion to a primary lung carcinoma of the right upper lobe

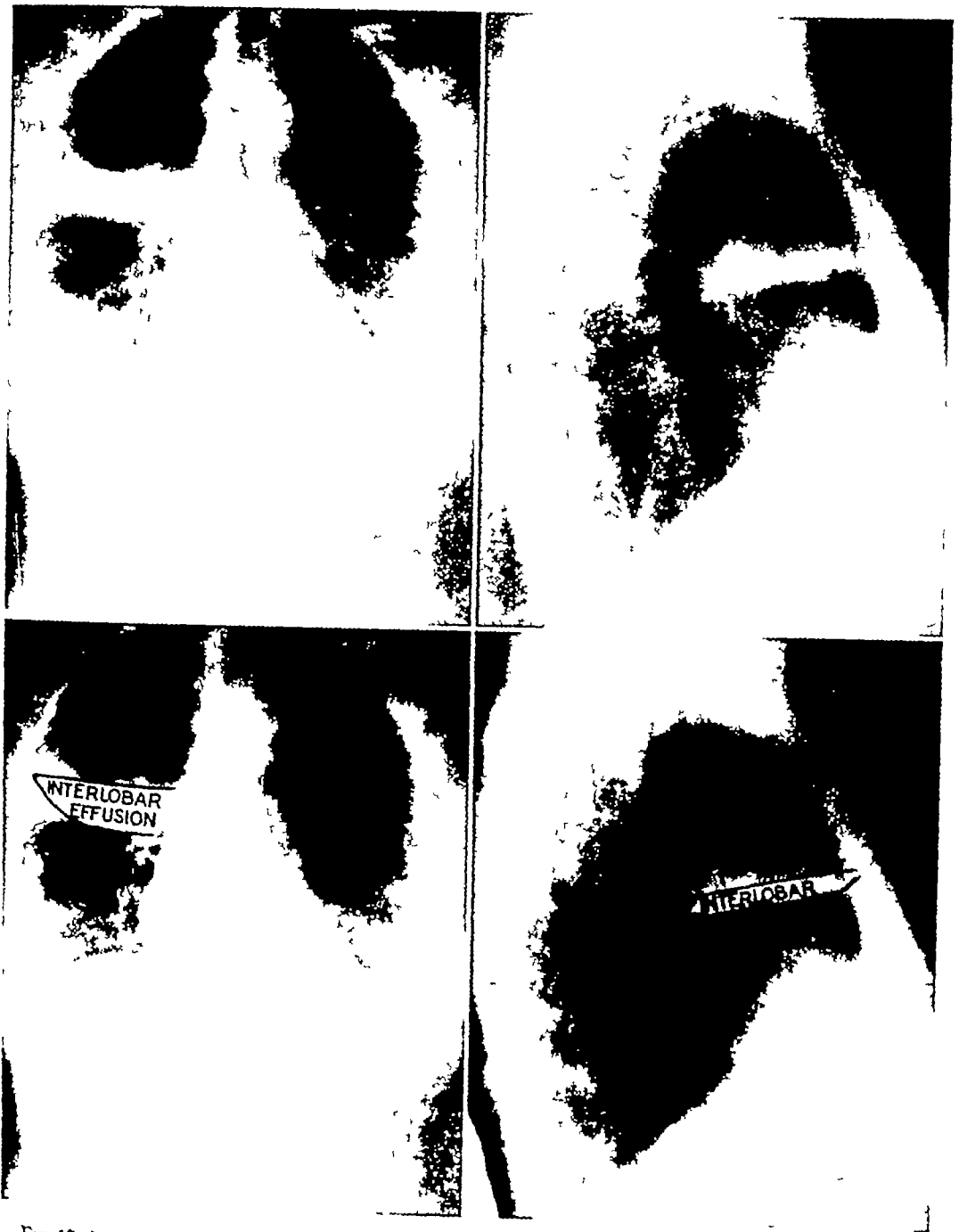
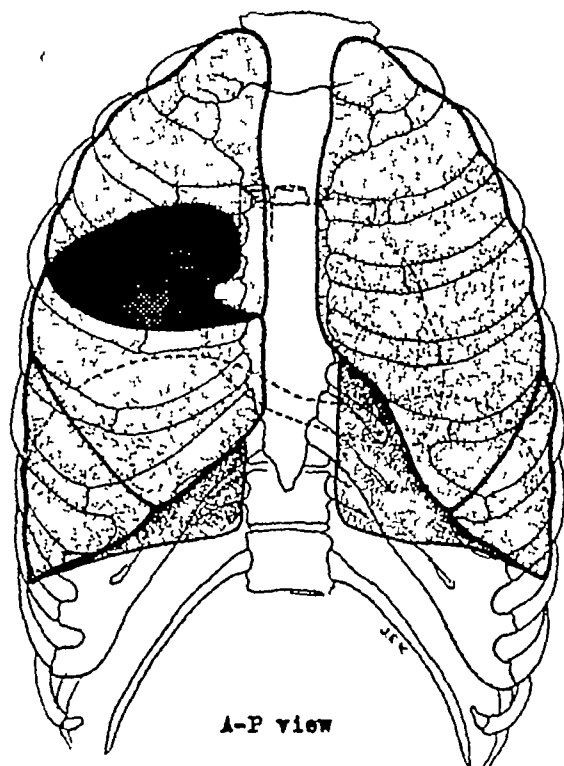


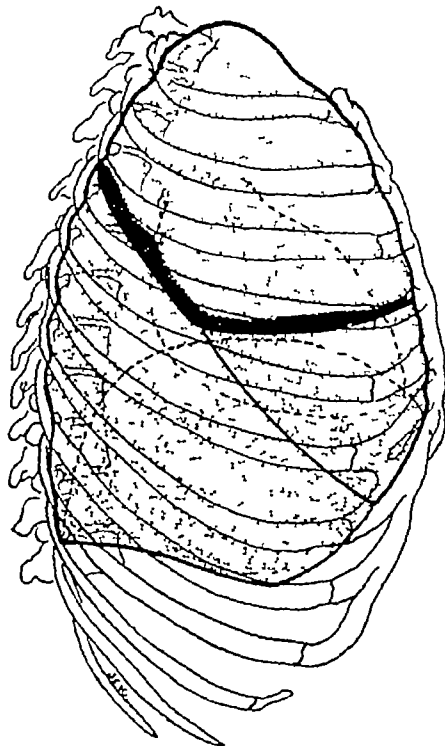
Fig 13 A Case 10 Interlobar effusion between the right upper and right middle lobes This effusion followed a pneumonia in the right upper lobe

case of pneumonia was found to be limited to the left upper lobe. This was a diffuse bronchopneumonia which later spread to the other lobes. One hundred cases of interlobar effusions were reviewed—of this number only two were found on the left

side and both were incomplete effusion, *i.e.*, not filling the entire interlobar space. The left lower lobe was found to be as frequently involved by pneumonia as the right lower lobe. It also showed the similar division into a superior and inferior part

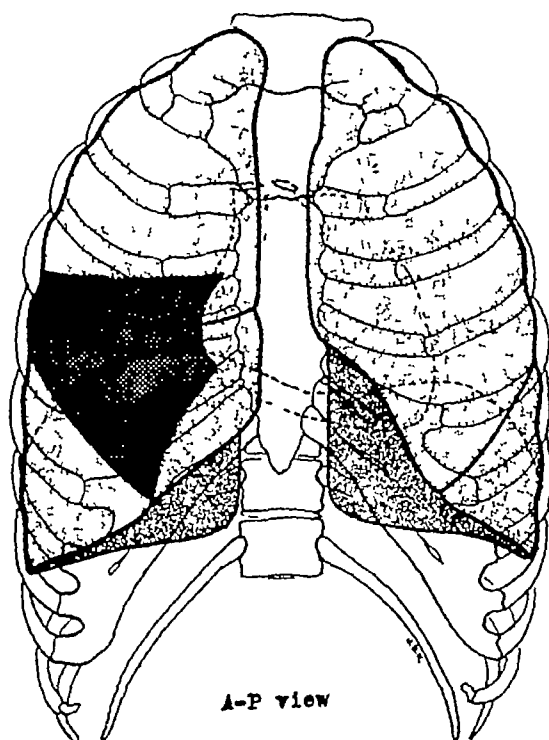


A-P view

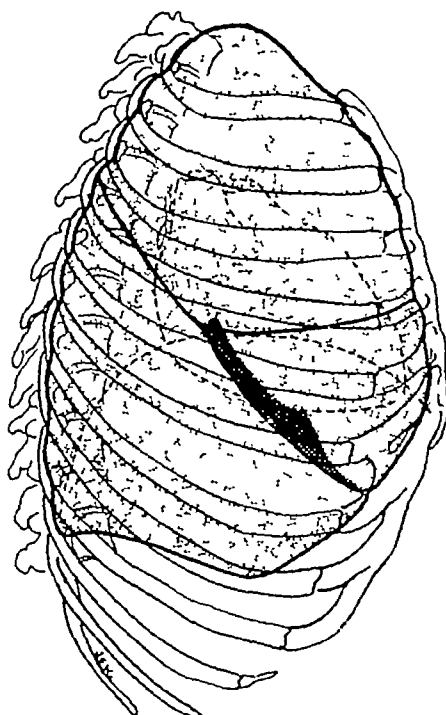


Lateral view

Fig 14 Interlobar fissure completely surrounding the right upper lobe



A-P view



Lateral view

Fig 15 Interlobar fissure between the right middle and right lower lobes

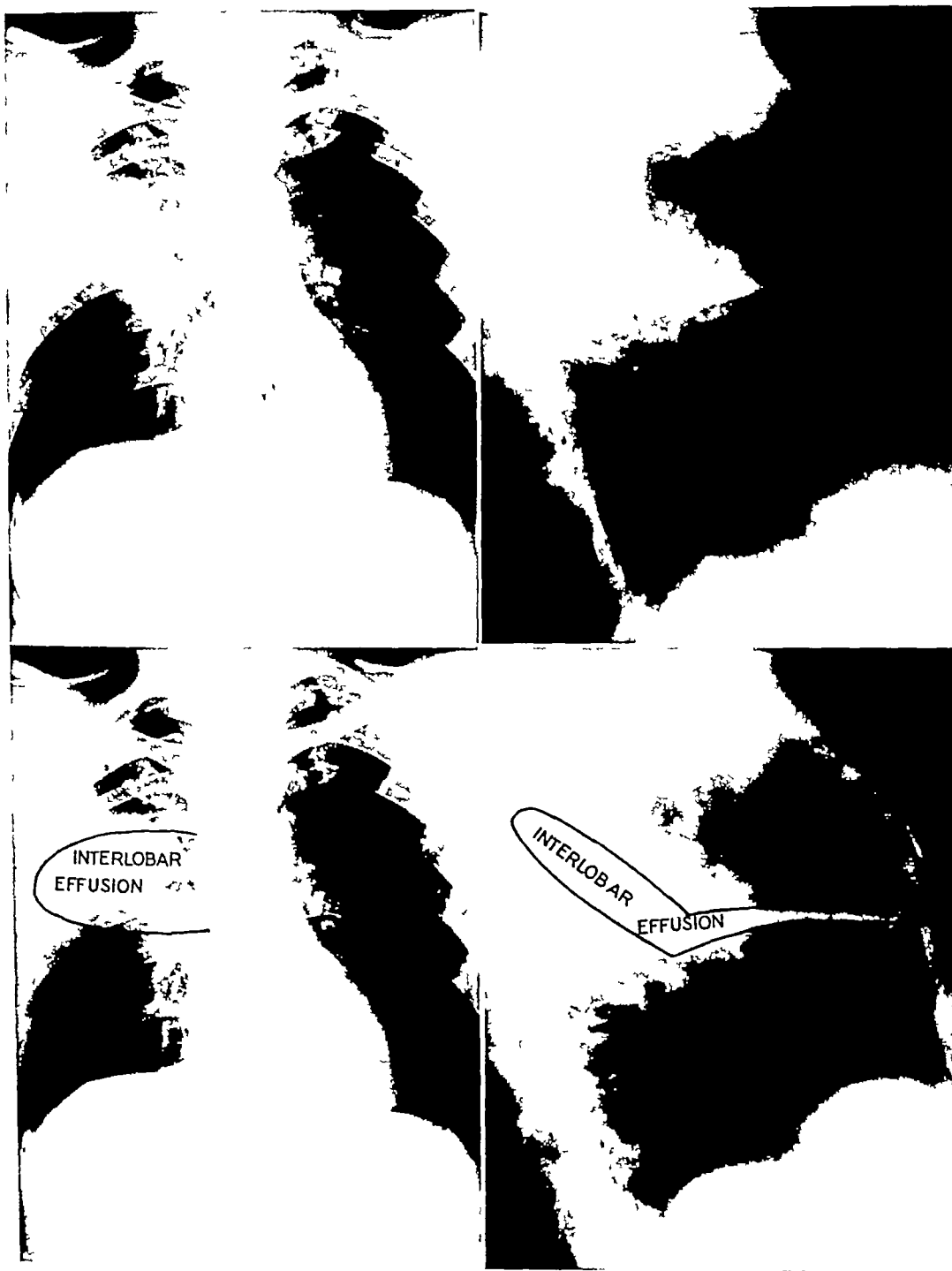


Fig 14 A Case 11 Interlobar effusion between the right upper and lower lobes posteriorly and the right upper and middle lobes anteriorly. This effusion followed a pneumonia in the right upper lobe. Involvement of both these fissures results in a centrally located area of lessened density which may be mistaken for the breaking down of the lung parenchyma into an abscess cavity. The course of this patient was not that of a lung abscess. The process promptly cleared.



Fig 15-A Case 12 Interlobar effusion between the right middle and right lower lobes. This effusion often extends laterally so as to occupy the entire interlobar fissure. If the entire fissure is involved, the shadow in the anteroposterior view would be similar to that in Figure 2-A. The lateral view demonstrates the oblique position of this shadow with the tapering at both ends. This view is essential to establish the diagnosis, and differentiates a consolidated middle lobe from an interlobar effusion between the middle and lower lobes.

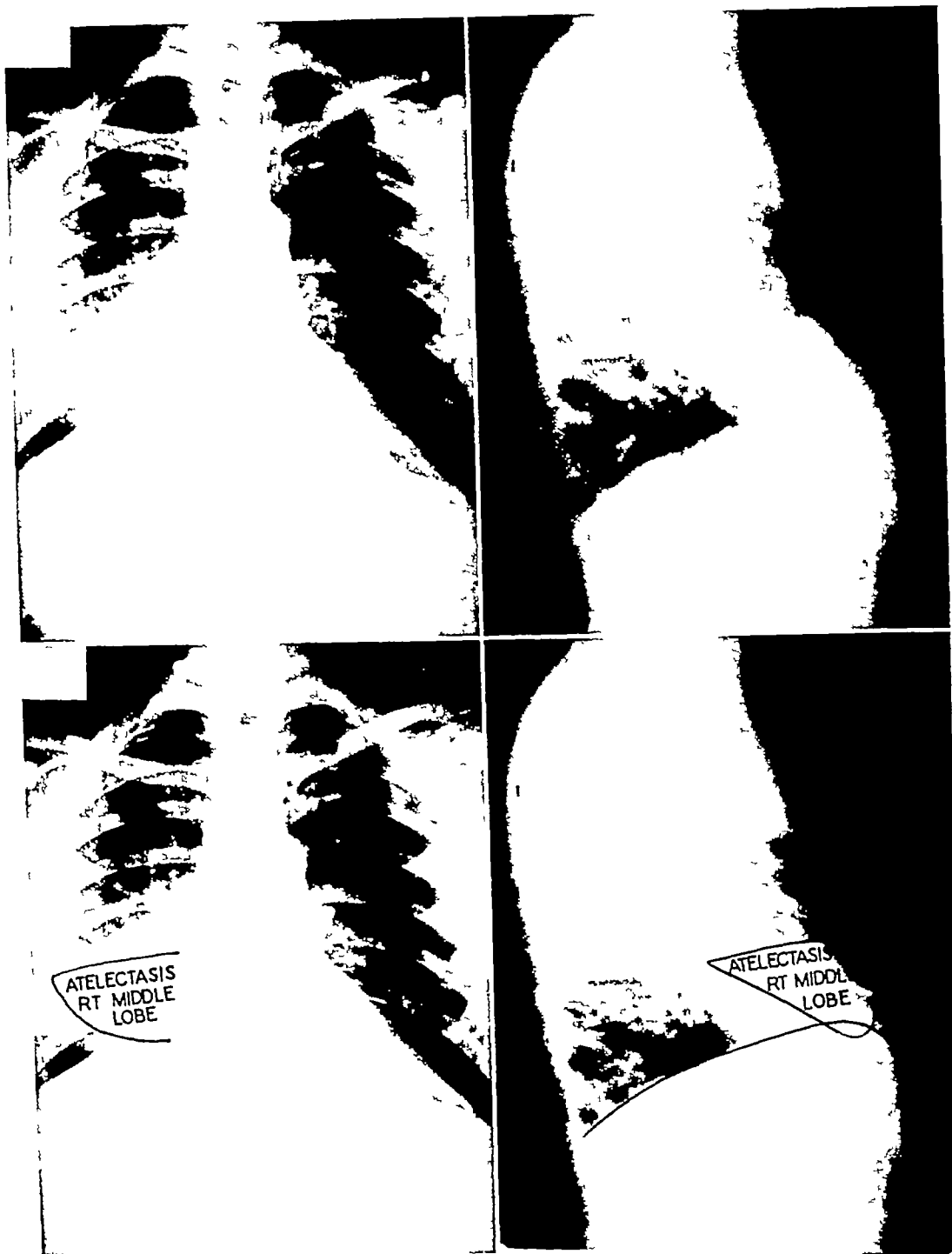


Fig 10 Case 13 Atelectasis of the right middle lobe as a result of a primary bronchial carcinoma. Note the small size of the middle lobe. The lateral view may be confused with an interlobar effusion. The anterior tip of this shadow (in the lateral view) is not tapered as is seen in the interlobar effusion (Figure 15 A). The base is broad as is seen in the consolidated middle lobe (Figure 2-A).



Fig 15 A Case 12 Interlobar effusion between the right middle and right lower lobes. The shadow often extends laterally so as to occupy the entire interlobar fissure. If the entire shadow in the anteroposterior view would be similar to that in Figure 2-A. The lateral view shows the oblique position of this shadow with the tapering at both ends. This view is essential for diagnosis, and differentiates a consolidated middle lobe from an interlobar effusion between the lower lobes.

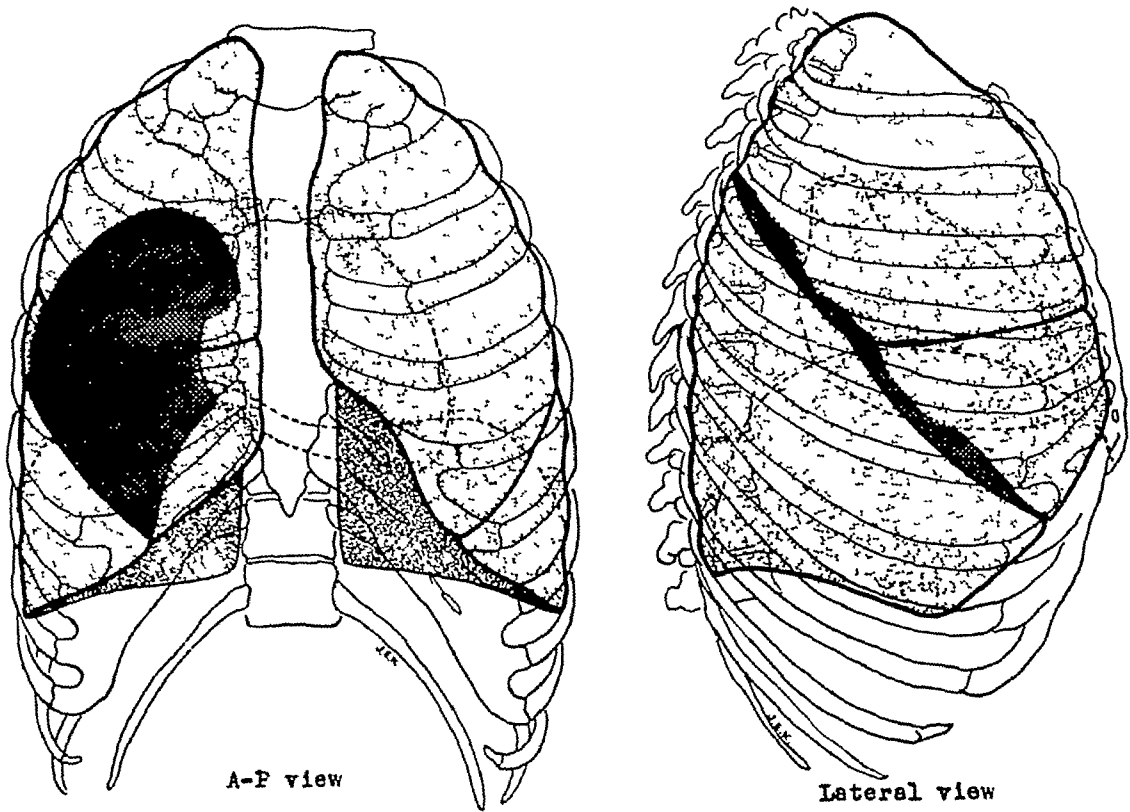


Fig 18 Interlobar fissure bordering the upper surface of the right lower lobe (the major fissure separating the lobes)

The Left Upper Lobe (Fig 8) —The shadow of this lobe on the roentgenogram is a shadow similar to the combination of the right upper and middle lobes. It occupies the upper and anterior part of the chest and overlies most of the cardiac shadow. No cases of consolidation limited to this lobe were found suitable for reproduction in the series studied.

The Left Lower Lobe (Fig 9) —The left lower lobe is similar in appearance, size, and position to the right lower lobe. It is similarly divided into a superior and inferior division.

Superior Division of Left Lower Lobe (Fig 10) —The appearance of this part of the lobe is similar to the superior division of the right lower lobe.

Inferior Division of Left Lower Lobe (Fig 11) —This part of the lung is also similar to the counterpart on the right side.

THE INTERLOBAR FISSURES

Interlobar Fissure between the Right Upper and Right Lower Lobes (Fig 12) —This part of the chest is the only place where the right upper and lower lobes are to contact. This fissure extends from the hilus obliquely upward. In the postero-anterior projection this fissure appears as a broad shadow which is often misinterpreted as lung involvement. The lower border appears as a horizontal line extending outward from the hilus. The upper border is convex, corresponding to the contour of the upper border of the lower lobe. The lateral view clearly demonstrates the oblique position of this fissure.

Physical signs of involvement of this fissure by an effusion may be absent. This is easy to understand because this fissure approaches the chest wall only in the axilla —its narrowest part. In front and in back



Fig 17 Case 14 Superimposed cardiac shadow and elevated diaphragm In the lateral view is seen an oblique dense shadow, tapering toward the tips extending from the hilus forward and downward This superimposed shadow has often been misinterpreted as interlobar effusion Comparing the anteroposterior view to that of the middle lobe consolidation (Figure 2) and the fissures between the middle and lower lobes (Figure 15) it is noted that the broad shadow extending from the hilus toward the axilla and base is absent and the right diaphragm is elevated

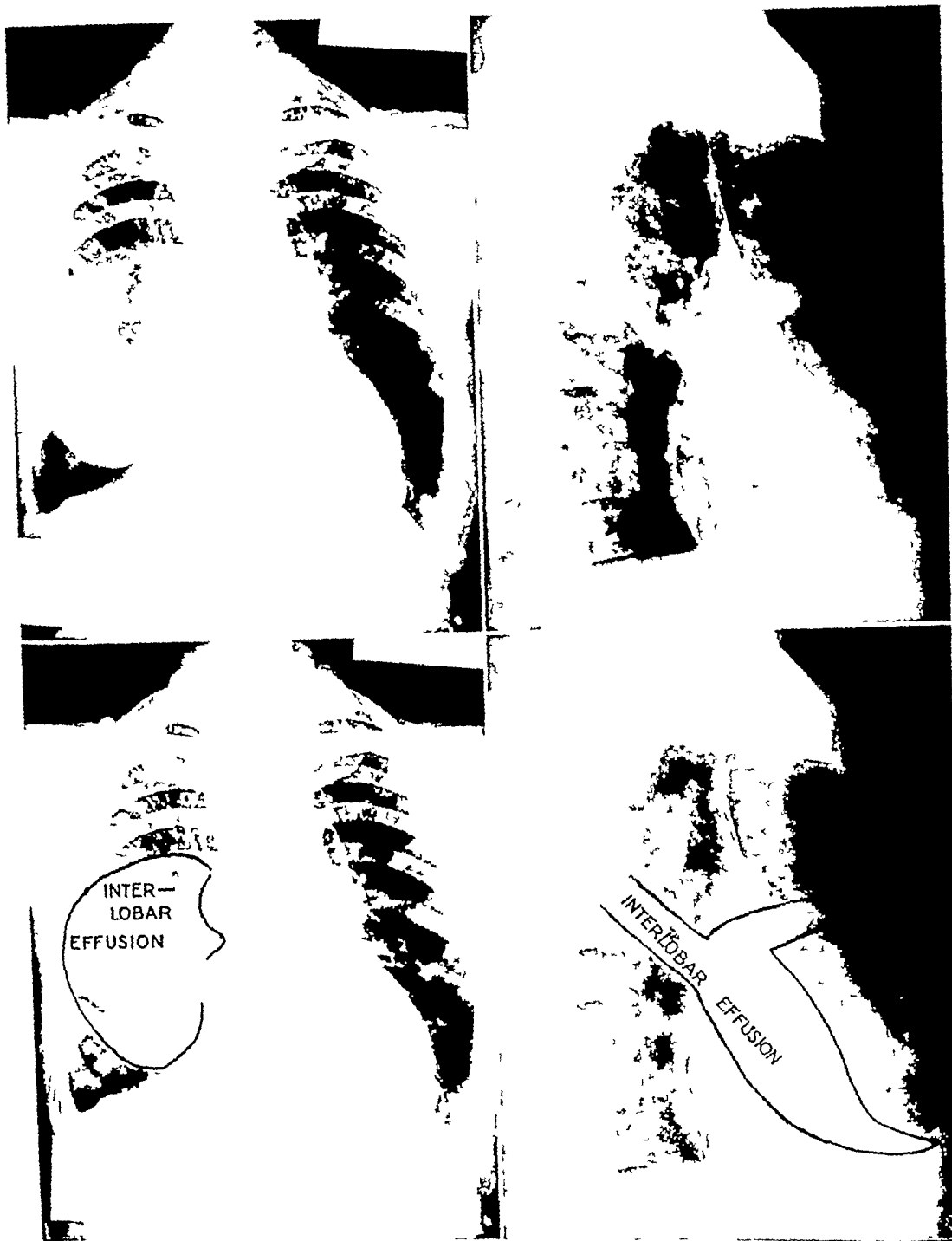
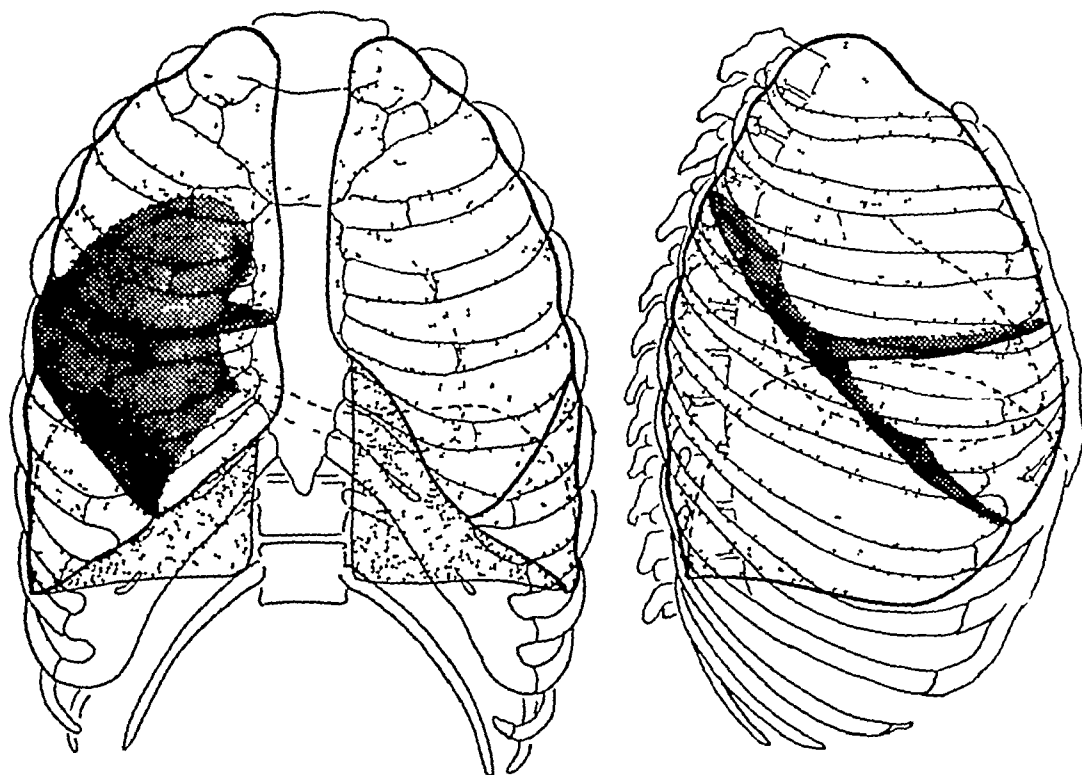


Fig 19 A Case 15 Interlobar effusion between all the lobes on the right side the result of cardiac failure Note the broad shadow of the interlobar fissure in the postero anterior view



A P view
Fig 19 Interlobar fissure between all the lobes on the right side

of this fissure is lung parenchyma which, if not involved, would not transmit the dullness of an effusion

Interlobar Fissure between Right Upper and Right Middle Lobes (Fig 13)—This fissure extends forward from the hilus to the anterior chest wall. On the postero-anterior projection the lower border is convex and corresponds to the shape of the lower margin of the upper lobe. The upper border is horizontal, extending from the hilus to the axilla. The lateral view shows the fissure to extend forward almost horizontally, from the hilus to the anterior chest wall.

A study of the diagram illustrates why physical signs of an effusion in this fissure would be absent. Again we have the process overlapped by considerable lung which, if not involved, would not transmit the dullness of the effusion.

The Fissure Completely Surrounding the Right Upper Lobe (Fig 14)—The shadow

cast by this fissure is a combination of the shadows obtained in Figures 12 and 13. The upper border is convex, corresponding to the contour of the upper margin of the lower lobe. The lower border has the shape of the lower border of the upper lobe on the anterior chest wall. Because of the broad shadow obtained in the postero-anterior view, which is less dense centrally near the hilus, involvement of these two fissures has often been misinterpreted as lung involvement and frequently as a lung abscess. Since interlobar effusions most frequently follow pneumonia and account for the subsequent temperature, and lung abscesses are often complications of pneumonia, the interpretation of this shadow as a lung abscess is a pitfall which must be guarded against. The lateral view clearly demonstrates the contour of this fissure. It is the posterior fissure, lying obliquely, which accounts for the broad shadow.

Interlobar Effusion between the Right

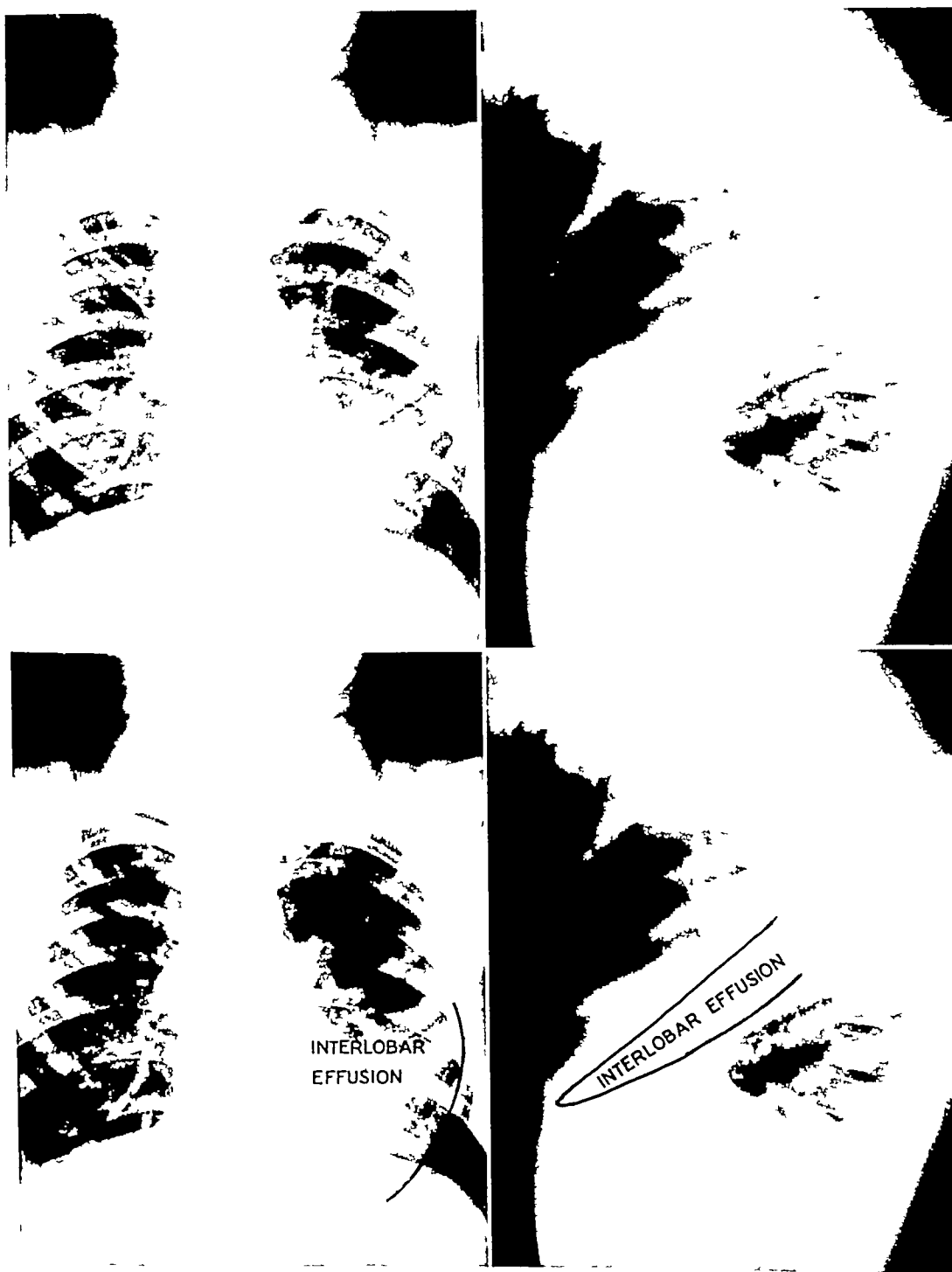


Fig 20 A Case 16 Interlobar effusion in anterior half of the interlobar fissure on the left side.

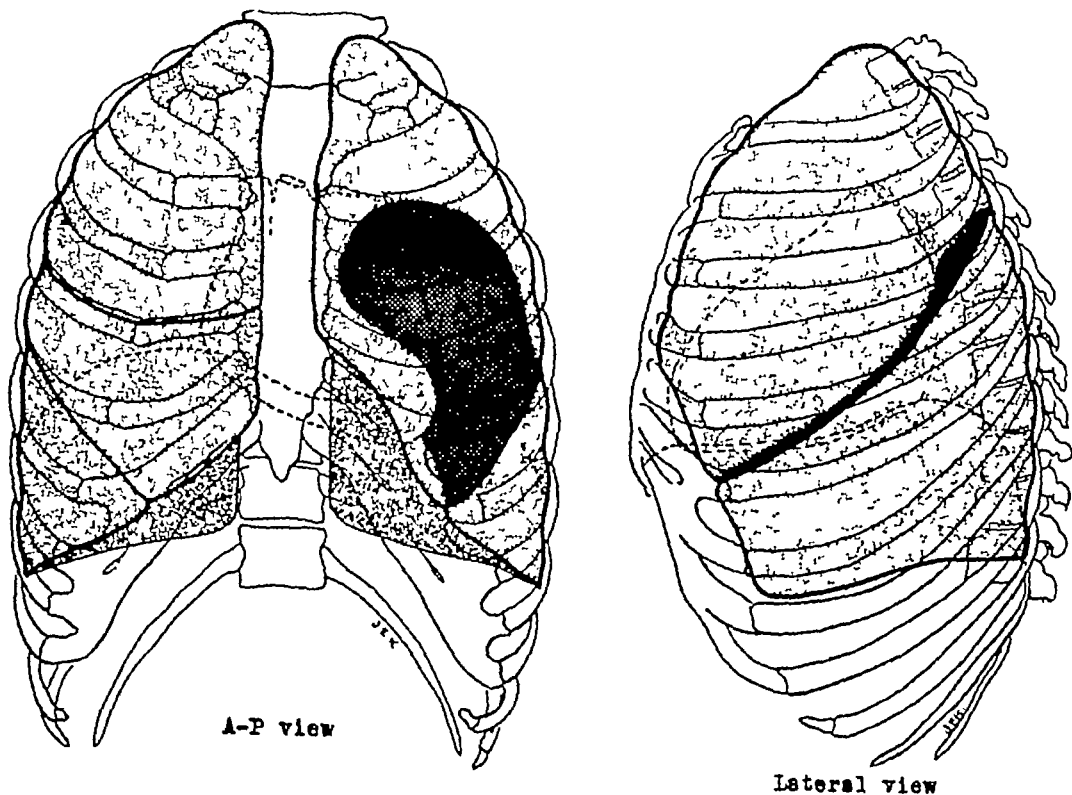


Fig 20 Interlobar fissure between the left upper and left lower lobes

Middle and Lower Lobes (Fig 15) —Effusion between these lobes is the most frequent of all interlobar effusions. It is also the most interesting, as it is so often incorrectly diagnosed. A study of the postero-anterior view shows the similarity of the shadow of this fissure with the shadow of the middle lobe. (Compare Figures 2 and 15.) The oblique course of this fissure, clearly demonstrated on the lateral view, explains the reason for the broad shadow seen on the roentgenogram in the postero-anterior view.

COMMON ERRORS WHICH MAY BE MADE IN THE DIAGNOSIS OF EFFUSIONS BETWEEN THE MIDDLE AND LOWER LOBES

(1) *Atelectasis of the Middle Lobe* (Fig 16) —Atelectatic lung is smaller than normal lung. The middle lobe is a small lobe and when atelectatic may diminish so in size as to approach the size of a large effusion between the lobes. Atelectasis of this

lobe may be confused with an interlobar effusion.

(2) *High Diaphragm, Superimposed over Cardiac Shadow* —This is a frequent error in diagnosis, and the overlapping oblique shadow, tapering at each end, has often been confused with an interlobar effusion between the middle and lower lobes. (See Fig 17.)

Occasionally a pendulous breast shadow superimposed over the shadow of the diaphragm will give a similar oblique, tapered, dense shadow in the lateral view, which may be erroneously diagnosed interlobar effusion. The postero-anterior view will again rule out that diagnosis by the absence of the broad shadow in the lower chest extending outward from the hilus.

Right Interlobar Fissure Bordering the Upper Surface of the Lower Lobe (The Major Fissure Separating the Lobes) (Fig 18) —This fissure separates the lower lobe from the upper lobe posteriorly (the hilus to the posterior chest wall), and the lower

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By WILLIAM EARL ANSPACH, M D , *Chicago*

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THE ability to place patient, x-ray tube, and film in such relationship that some selected anatomical structure in the chest, abdomen, or pelvis shall appear at the center of the finished roentgenogram is an accomplishment much to be desired in a roentgenologist or his lay helper. Two general problems are involved: first, one must line up tube and film until the target lies perpendicularly above the center of the

of the film. The second problem is the subject of the present dissertation.

Sitting Height—The sitting height of a subject is obviously closely related to the length of his spine and so this measurement was the first one used. Subjects were made to sit on a stool, their backs against a standard height board, and then, after sitting height had been measured, they were placed back down on the x-ray table

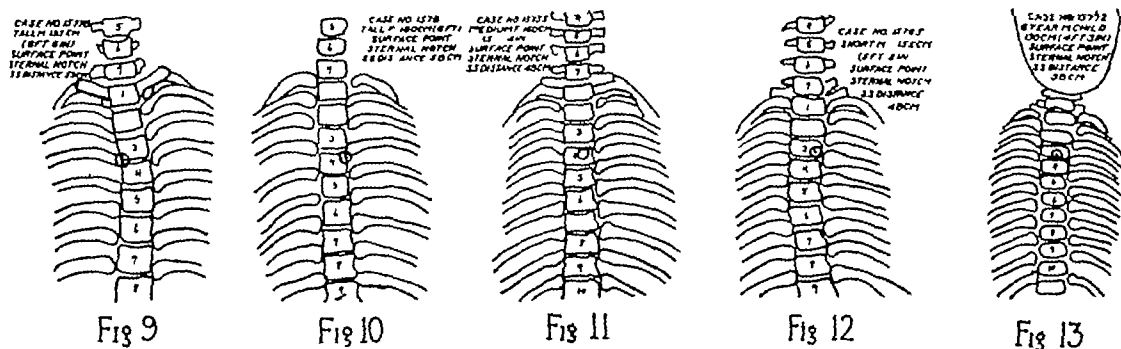


Plate I Tube and film centered at suprasternal notch. Dot and circle indicate film center. In these five subjects the notch corresponds closely to the body of the fourth thoracic vertebra.

film, second, one must know what point on the skin of the patient's body lies directly above the anatomical structure selected for examination.

The first of these problems is more or less time-consuming if commercial types of apparatus are employed. In this particular laboratory it has been disposed of by equipping all exposing tables with special tube arms similar to the one on the obstetrical table described by Hodges and Ledoux.¹ When these tube arms are locked to the Potter grid and are made to stand at 90° to the table top, the target of the x-ray tube lies perpendicularly above the center

Measuring downward from the vertex along the anterior surface of the body in a plane parallel to the table top, a point was located halfway from crown to rump. The patient was now arranged on the table so that this $\frac{1}{2}$ S H (half sitting height) point lay along an imaginary perpendicular joining the target of the x-ray tube and the center of the film, and the exposure was made.

In six adults ranging in build from short and fat to tall and lean, this one-half sitting height point was found to correspond to that portion of the spine bounded above by the center of the eighth thoracic vertebra, below by the center of the ninth thoracic vertebra. In one eight-year-old child it corresponded to the body of the eighth thoracic and in another, six years old, to the seventh thoracic vertebra. However, sitting height does not

¹ Abbreviated from a dissertation submitted to the graduate faculty of the University of Chicago in candidacy for the Degree of Master of Science.

Requests for reprints or other correspondence relative to this paper should be directed to the Division of Roentgenology, University of Chicago.

lobe from the middle lobe anteriorly (the hilus to the anterior chest wall)

The shadow of this fissure is a combination of the shadow (Figures 12 and 2) described above. In the postero-anterior view the shadow is broad, extensive, and bean-shaped. It can be easily mistaken for a large tumor. The lateral view clearly establishes the position of this shadow within the interlobar fissure.

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SUMMARY

A set of diagrams is presented, illustrating the roentgenological appearance of the lobes of the lung and the interlobar fissures in the normal lung.

Roentgenograms of known clinical cases, illustrating the diagrams, are also presented.

Common errors in the diagnoses of some of these conditions have been pointed out.

CONCLUSION

We are indebted to Dr A. L. Brown for suggestions and criticisms, and wish to thank Mr J. Kelso, medical artist and photographer, for his assistance in the preparation of the diagrams and photographs.

510 Sutter St

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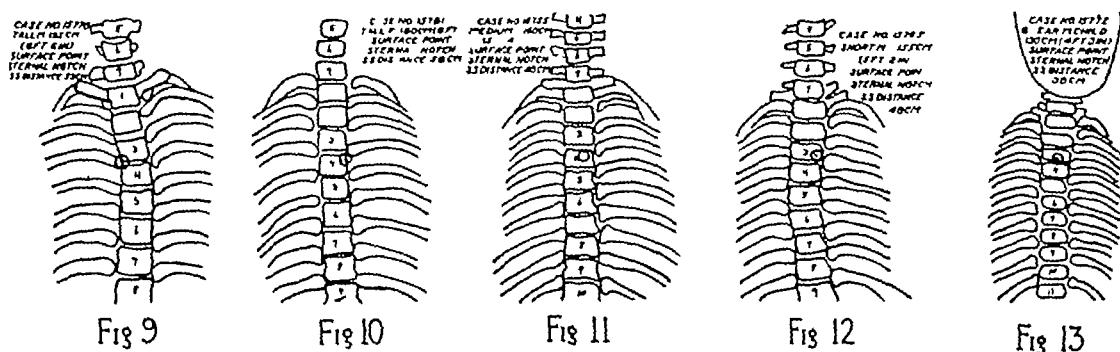


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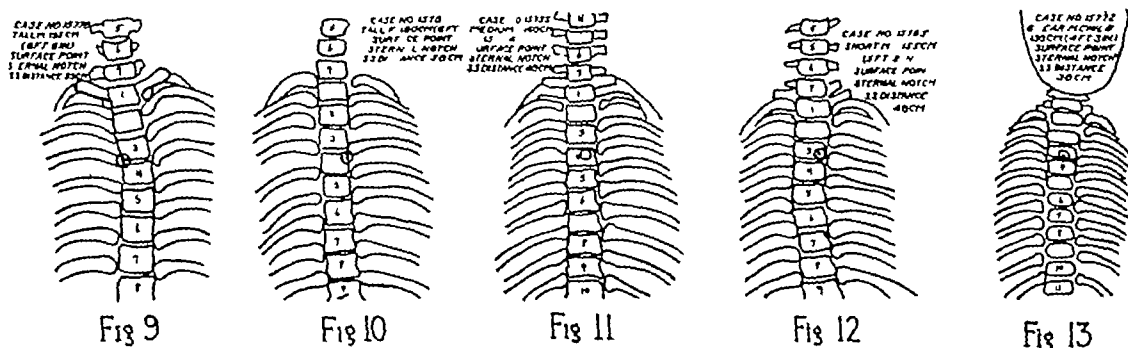


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The first of these problems is more or less time-consuming if commercial types of apparatus are employed. In this particular laboratory it has been disposed of by equipping all exposing tables with special tube arms similar to the one on the obstetrical table described by Hodges and Ledoux.¹ When these tube arms are locked to the Potter grid and are made to stand at 90° to the table top, the target of the x-ray tube lies perpendicularly above the center

Measuring downward from the vertex along the anterior surface of the body in a plane parallel to the table top, a point was located halfway from crown to rump. The patient was now arranged on the table so that this $\frac{1}{2}$ S H (half sitting height) point lay along an imaginary perpendicular joining the target of the x-ray tube and the center of the film, and the exposure was made.

In six adults ranging in build from short and fat to tall and lean, this one-half sitting height point was found to correspond to that portion of the spine bounded above by the center of the eighth thoracic vertebra, below by the center of the ninth thoracic vertebra. In one eight-year-old child it corresponded to the body of the eighth thoracic and in another, six years old, to the seventh thoracic vertebra. However, sitting height does not

¹ Abbreviated from a dissertation submitted to the graduate faculty of the University of Chicago in candidacy for the Degree of Master of Science.

Requests for reprints or other correspondence relative to this paper should be directed to the Division of Roentgenology, University of Chicago.

lend itself well to such work because the measurement cannot be made as the patient lies on the table ready for examination

spines, and iliac crests could not be palpated with sufficient precision. On the other hand, the suprasternal notch, which

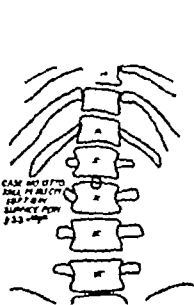


Fig 14

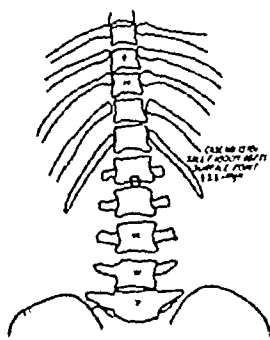


Fig 15

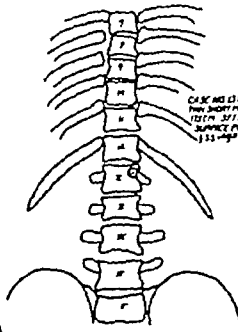


Fig 16

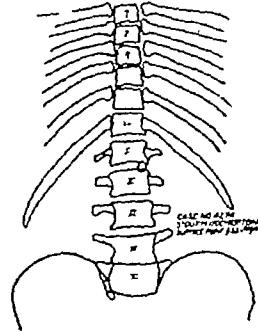


Fig 17

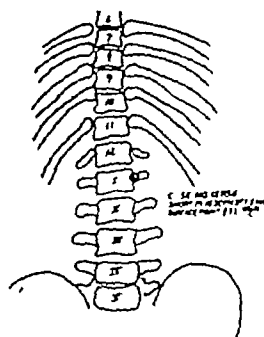


Fig 18

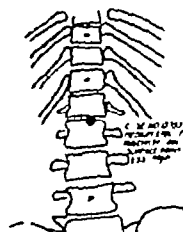


Fig 19

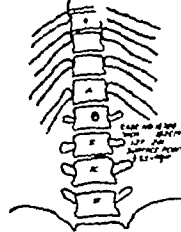


Fig 20

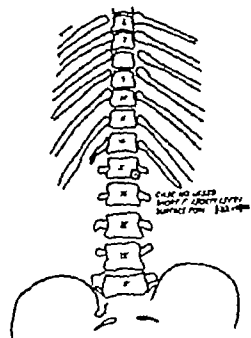


Fig 21

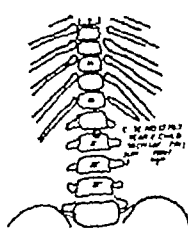


Fig 22

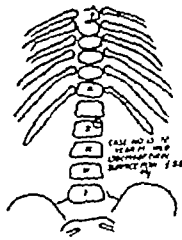


Fig 23

Plate II Tube and film centered at middle of S-S axis. In these ten subjects this point corresponds to the body of the first lumbar vertebra

S-S Axis (suprasternal notch—symphysis pubis axis)—Obviously the measurement of choice should be related to landmarks on the anterior surface of the body. Several such landmarks on examination proved unsatisfactory; the umbilicus did not have a constant relationship to spinal segments and the costal margin, iliac

is always easy to locate regardless of age, sex, or build, was found to correspond closely to the fourth thoracic vertebra (Plate I), suggesting that this landmark might be used as the upper end of an axis.

A lower mark was now sought and after some study the superior margin of the symphysis pubis was selected as the best

one available. General experience has suggested that the symphysis might not be a dependable guide because presumably its re-

pubis along the S S axis ($\frac{3}{4}$ S S) corresponded to the body of the fifth lumbar vertebra (Plate III), and $\frac{1}{4}$ S S lay directly

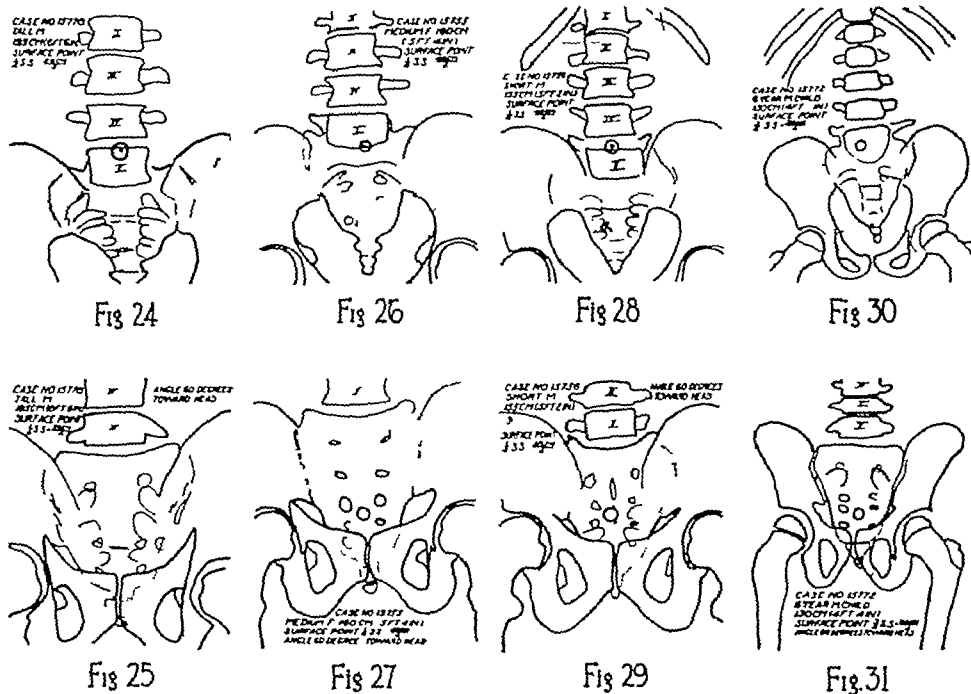


Plate III In the four upper figures (24 to 30), the tube and film are centered on the S S axis one-quarter of the distance up from the upper surface of the symphysis pubis. With the radiation directed at 90° to the plane of the film, the body of the fifth lumbar vertebra appears at the center of the roentgenogram.

In the four lower figures (25 to 31), the film is centered as before at the one quarter S S point but the tube is moved toward the subject's feet so that an imaginary line joining the center of the film and the center of the target makes an angle of 60° with the plane of the film. This angulation displaces skeletal structures upward, gives a better view of the sacrum and brings the sacro iliac joints to the center of the film.

relationship to neighboring structures would vary with sex and with the degree of inclination of the fifth lumbar on the first sacral vertebra. It was obvious also that it would fall below the lower end of the spine but this, of course, did not interfere with its use as the lower end of an axis. The "suprasternal notch—symphysis pubis axis" (abbreviated S S axis) is an imaginary line parallel to the surface on which the patient lies, tangent to the most prominent part of his anterior abdominal wall and terminated above by the suprasternal notch, below by the upper surface of the symphysis pubis. The middle of this axis ($\frac{1}{2}$ S S) was found to correspond to the body of the first lumbar vertebra (Plate II). A point one-quarter of the distance up from the symphysis

above the ninth thoracic vertebra (Plate IV).

A Surface Landmark Chart—It was now possible to construct a surface landmark chart (Plate V) showing the relationship between points on the S S axis and segments of the spine over S S axes ranging from 36 to 60 centimeters. This involves extrapolation below the observed values for some of the diagonals, but subsequent experience with the chart indicates that the extrapolation is sound. An S S axis of 36 cm indicates a child approximately ten years old. Children younger than this seldom present much difficulty because their bodies are so small in comparison to the size of the film used that exact centering is of no great importance.

The chart is used as follows With the subject on his back on the exposing table, the examiner palpates the superior margin

on the skin lying perpendicularly above the first lumbar vertebra In the column at the left of the chart, one locates the end of the

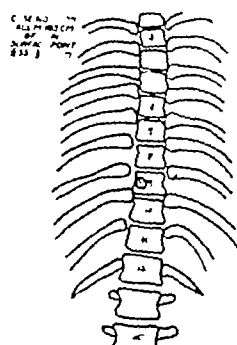


Fig 32

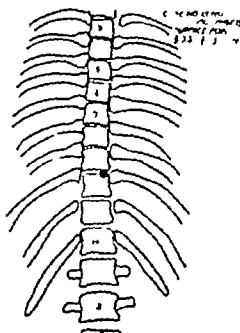


Fig 33

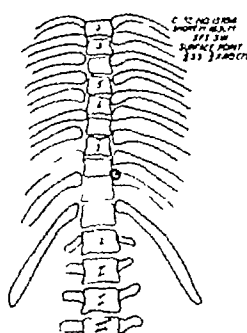


Fig 34

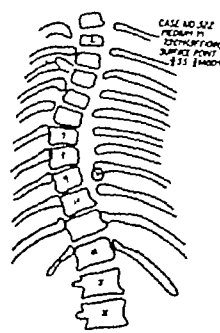


Fig 35

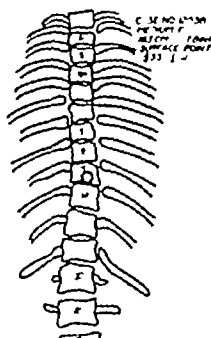


Fig 36

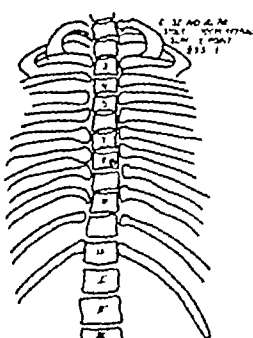


Fig 37

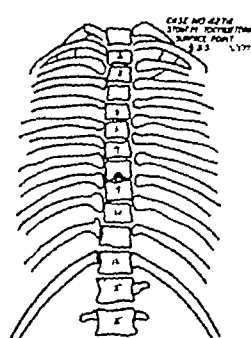


Fig 38

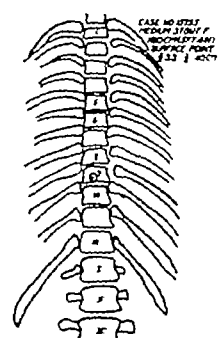


Fig 39

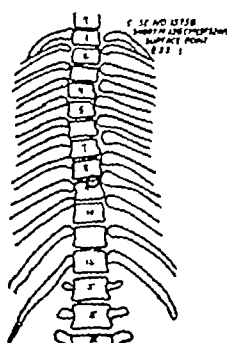


Fig 40

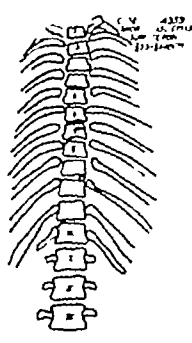


Fig 41

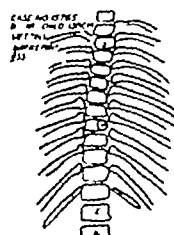


Fig 42

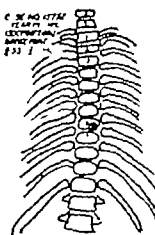


Fig 43

Plate IV Tube and film centered at $\frac{3}{4}$ S S point closely to the body of the ninth thoracic vertebra

Film center (marked by dot and circle) corresponds

of the symphysis pubis and of the sternal notch and marks these points on the skin The straight-line distance between the two points is measured in a plane parallel to the table top and the measurement recorded Suppose now it is desired to locate the point

diagonal for the first lumbar vertebra and follows it downward and to the right to its intersection with the vertical line corresponding to the measured S S axis of the subject being examined For instance, if the S S axis is 50, the diagonal for the first

TABLE I

Figure No	Center Point	Portion of Spine Showing in Center of Film	
		As Predicted by Chart	As Actually Observed in the Roentgenogram
44	Suprasternal notch	Body of T 4	Lower surface of T 3
45	40 cm above symphysis pubis	Lower surface of T 8	Upper surface of T 7
46	23 cm above symphysis pubis	Body of L 2	Body of L 2
47	12 cm above symphysis pubis	Body of L 5	Body of L 5
48	4 5 cm above symphysis pubis	Pelvis	Pelvis
49	Same centering as in Fig 48, but with smaller film to show only lower urinary tract		

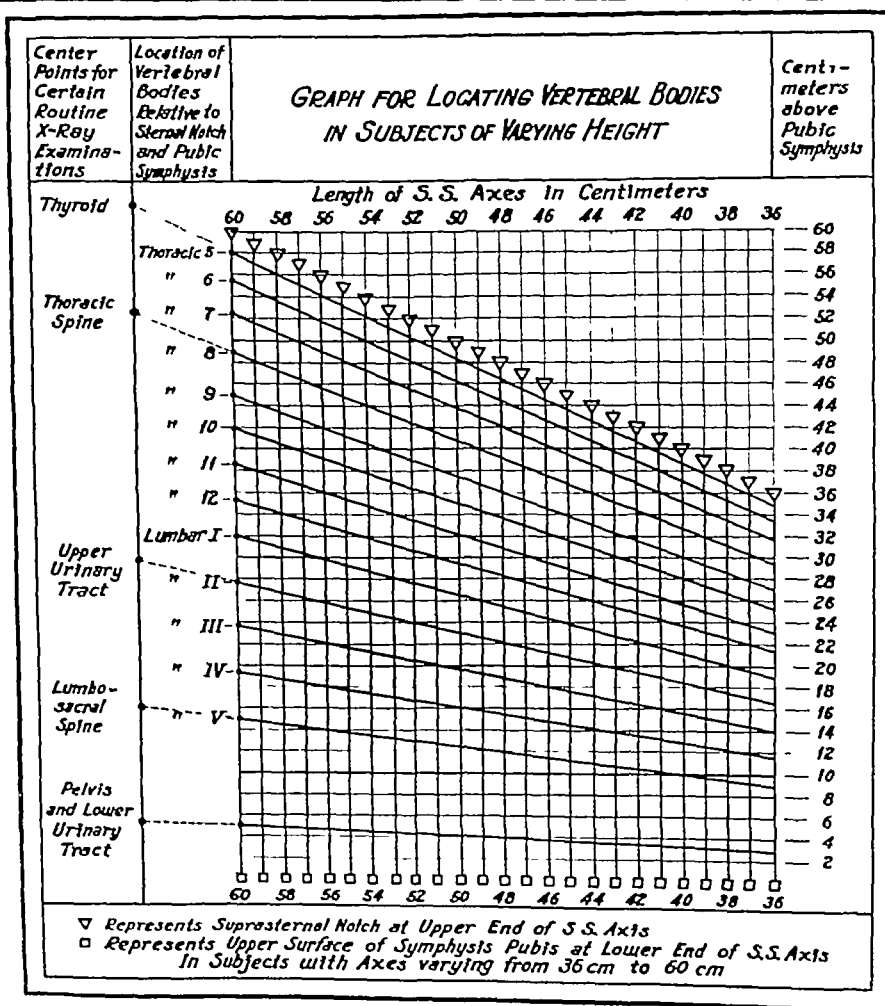


Plate V

lumbar vertebra will intercept it approximately 27 cm above the symphysis pubis. Accordingly, if one measures upward from the symphysis pubis 27 cm along the S S axis and makes a mark on the skin at this

point, the mark will lie perpendicularly above the body of the first lumbar vertebra. If the S S axis is 40 and the spinal segment in question is the fifth lumbar, the mark will be made 15 cm above the sym-

physis pubis, or if one wishes to locate the eighth thoracic vertebra and the subject has an S S axis of 48, the mark will be thoracic vertebra to the center of the film (theoretical value from chart, body of the eighth thoracic vertebra) Centering 23 cm

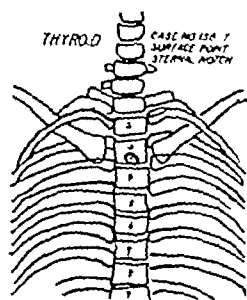


Fig 44

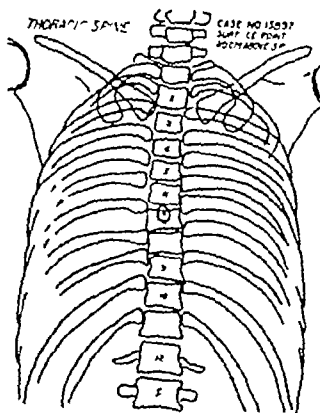


Fig 45

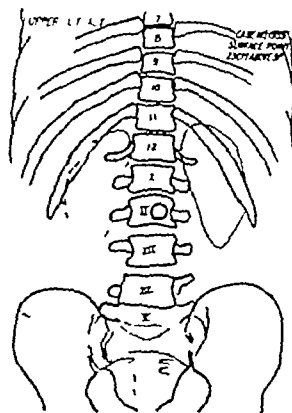


Fig 46

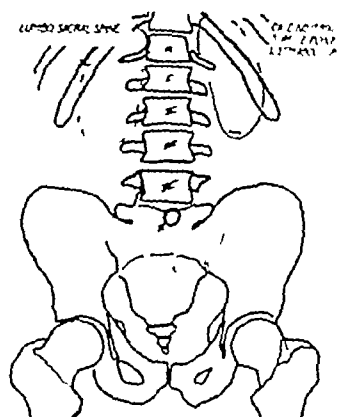


Fig 47

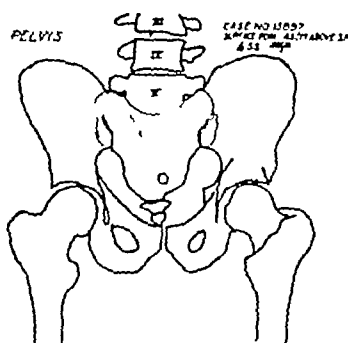


Fig 48



Fig 49

Plate VI Results obtained by use of chart in a subject 165 cm tall and having an S S axis of 50 cm

made 39 cm above the symphysis pubis. For our own convenience there has been added a left-most column (Table I) showing the levels at which we commonly center for examinations of the thyroid, the entire thoracic spine, the upper urinary tract, the lumbosacral spine, the pelvis, and the lower urinary tract.

Plate VI illustrates the results obtained in an adult 165 cm tall, whose S S axis measured 50 centimeters. Centering at the sternal notch (Fig 44, Plate VI) brings the disc between the third and fourth thoracic vertebrae to the center of the film. Centering 40 cm above the symphysis pubis (Fig 45, Plate VI) brings the body of the seventh

thoracic vertebra to the center of the film (theoretical value from chart, body of the eighth thoracic vertebra). Centering 23 cm above the symphysis pubis (Fig 46, Plate VI) places the second lumbar vertebra at the center of the film. The fifth lumbar vertebra lies directly beneath a point 12 cm above the symphysis (Fig 47, Plate VI), the pelvis is well placed if the film is centered 45 cm above the symphysis (Fig 48, Plate VI), and the same center point is satisfactory for 10 X 12 films of the lower urinary tract.

Oblique Views of Sacro-iliac Joints—For special examinations of the sacro-iliac joints many workers place the subject on his back and angle the radiation 60° toward the head to compensate for the inclination of the sacrum and thus spread out

its image on the film. Centering for the examination is somewhat difficult because parts lying farther forward are projected strongly upward, due to the angulation of radiation. We find that, centering film and grid at the fifth lumbar vertebra and then angling the radiation 60° toward the

head, the sacro-iliac joints usually appear at the middle of the completed film, regardless of the age or build of the subject.

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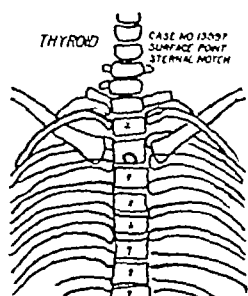


Fig 44

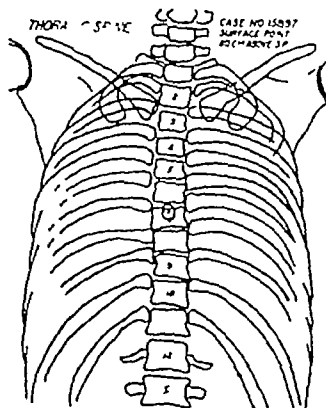


Fig 45

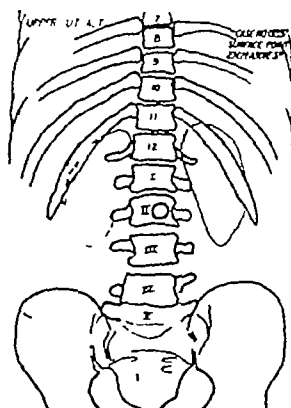


Fig 46

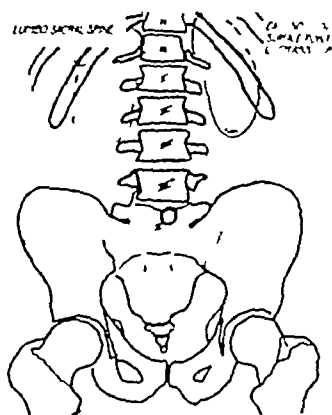


Fig 47

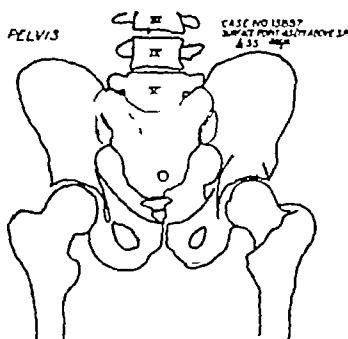


Fig 48

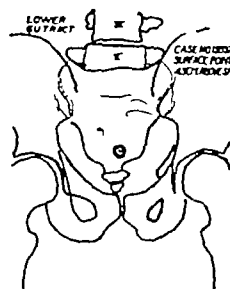


Fig 49

Plate VI Results obtained by use of chart in a subject 165 cm tall and having an S S axis of 50 cm

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Oblique Views of Sacro-iliac Joints—For special examinations of the sacro-iliac joints many workers place the subject on his back and angle the radiation 60° toward the head to compensate for the inclination of the sacrum and thus spread out

carcinoma increasing from the cecum toward the rectum (9)

It is logical to infer that the slower the material migrates through the gut, the greater opportunity there is for the production of chronic irritation or "wearing out" of the mucosa. This supports the generally accepted opinion that chronic irritation plays an important part in the causation of cancer.

Why Duodenal Ulcers do Not Become Malignant—Based on the chronic irritation theory, it was believed that an ulcer was a favorable soil for carcinomatous implantation. However, this idea does not harmonize with actual facts. Although ulcers are very common in the duodenum, occurring three to four times as frequently as gastric ulcers (4), duodenal carcinomas are nevertheless extremely rare. Lichty (16) reports that "in a series of 486 cases of duodenal lesions, six lesions were found to be cancerous and 480 benign ulcers. In 780 cases of gastric lesions, 240 were found to be cancers and 540 benign ulcers. Apparently then the ulcer-bearing areas do not coincide in the duodenum as they do in the stomach." Judd (14) states that he was unable to find in the records of the Mayo Clinic any evidences that a primary carcinoma of the duodenum arose from an ulcer. Lewis and Morse (7) claim that duodenal carcinoma probably arises independently, and that little evidence has been found that it ever has arisen in a pre-existing ulcer. Schofield (21) informs us that duodenal ulcer has never been proven to be a predisposing cause of duodenal carcinoma. Hinton (12) asserts that, clinically, one can disregard the possibility of duodenal ulcer ever taking on malignant degeneration.

The case which I shall describe in the latter part of this paper reveals a primary carcinoma in the ampullary portion of the duodenum, independent of an associated ulcer in the supra-ampullary portion, which also favors the opinion that there is no connection between the two types of lesion. In my opinion, duodenal ulcers are not apt to become malignant for the reason that the majority of them are really "acute"

and do not exist long enough to produce chronic irritation. These ulcers, which are small and superficial, are confined to the mucous membrane and will heal rapidly under medical treatment or no treatment at all (5). The recurrence of symptoms, following a period of freedom from distress, is generally due to the formation of a "new" ulcer at a different site. In the chronic ulcer, as originally described by Moynihan, there is destruction of the deeper racemose tubules and muscular coat, and this type of lesion may produce chronic irritation and become a favorable soil for carcinomatous implantation. The two cases presented by Arisz (1), in which callous duodenal ulcers have undergone malignant degeneration, belong to this category.

Symptoms and Physical Findings in Cases of Primary Carcinoma of Duodenum—Although there are relatively only a few reported cases dealing with duodenal cancer, the writer has been impressed with the manifold detailed description of symptoms and physical findings that accompanied nearly all these articles. An effort is even made to portray a set of symptoms for each of the three sections of the duodenum. One is almost imbued with the idea that the diagnosis can be made from the symptomatology alone. Pain, nausea, vomiting, distention, malaise, loss of weight, diarrhea, melena, palpable abdominal mass, succussion splash, low red cell and hemoglobin, etc., may occur in any case of malignancy in the gastro-intestinal tract. The symptom of jaundice is emphasized by most of the writers as being present only in carcinoma of the ampullary portion of the duodenum (20). Absence of free HCl in gastric contents, and presence of occult blood following a meat-free diet are also considered important diagnostic features (19).

Roentgenologic Consideration—Carman (4), in his second edition of "Roentgen Diagnosis of Diseases of the Alimentary Tract," published in 1920, states that cancer in the supra-ampullary area is not to be differentiated roentgenologically from duodenal ulcer. In describing the ampullary and infra-ampullary lesions, he asserts that

DUODENAL CARCINOMA ITS RELATIONSHIP TO DUODENAL ULCER

By I S STARTZ, M D, *Boro of Queens, N Y*

THE subject of carcinoma is always a vital consideration, especially in view of the fact that so little is known as regards its etiology and specific treatment, and that it has taken second place (3) as cause of death in our U S mortality statistics. And to go further, there is the realization that 75 per cent of all cancer cases occur in some part of the digestive system (6).

It is a surprising fact that two-thirds of the entire alimentary tract, namely, the small intestine, is almost immune from carcinomatous implantation. Primary carcinoma of the duodenum is a rarity. Eger (8), in collecting data from general autopsies totalling 350,286 cases, reports primary carcinoma of the duodenum in only 0.033 per cent of cases. Herman and Von Glahm (11), in their average incidence from autopsy combined figures by Max Muller, Perry and Shaw, Northnagel, Ruepp, Tieman, and Fritz Muller, quote a surprising and almost similar percentage of 0.035. It is customary to divide the duodenum into the first or supra-ampullary portion, the second or ampullary portion, and the third or infra-ampullary portion. Of the three divisions of the duodenum, 70 per cent of the cases reported (4) occur in the ampullary portion, 18 per cent in the supra-ampullary portion, and 12 per cent in the infra-ampullary portion. The duodenum is attacked almost as frequently as the jejunum and ileum combined.

The graphic chart (Fig 1) has been compiled from average available statistics. It portrays more vividly the anatomic incidence of duodenal cancer in relation to other cancers of the gastro-intestinal tract, and to cancers as a whole.

Explanation Offered for Infrequency of Carcinoma of the Small Intestine—Just why the small intestine should be relatively cancer-resistant, and the other parts of the

alimentary tract, particularly the stomach, cancer-sensitive, is difficult to explain. The two contiguous portions of the pars pylorica and the duodenal cap do not present any sharp demarcation in the histologic appearance of the mucous membrane. Piersol's anatomy describes a "gradual" transformation in the structure of the mucous membrane between the two. Even the pyloric sphincter cannot always be recognized by the surgeon as the division line without utilizing the pyloric veins as a landmark (17). Nevertheless, the pyloric sphincter is the gate between the prepyloric cancer zone and the post-pyloric non-cancer zone.

Let us, therefore, discard the histologic study, and consider the matter from the physiologic viewpoint. The motility of the chyme is greater in the small intestine than in any other part of the gastro-intestinal tract. The average time required for the passage of food through the twenty feet of small intestine is four and three-eighths hours (13). The average meal in the stomach, while undergoing digestion, sojourns as long as from three to six hours in its migration from the cardiac end to the pyloric sphincter, a distance of eleven inches. The colon content gradually decreases in its motility from the cecum to the rectum. Correlating these facts with the incidence of gastro-intestinal cancers, there appears to be a direct relationship between the motility of the food and the frequency of carcinoma in the various portions of the gut. In other words, the predilection of primary carcinoma is in inverse proportion to the physiologic rate at which the food is propelled through the gastro-intestinal tract. On this basis, we can explain the large number of cases of carcinoma in the stomach, the rarity of carcinoma in the small intestine, and the reason for the incidence of



Fig 2 (*upper left*) Roentgenogram made in upright posture showing hydroscopic levels in the distended intestinal loops due to stasis, caused by a carcinoma of the upper descending colon near the splenic flexure

Fig 3 (*upper right*) Roentgenogram in upright position showing multiple fluid level pockets within distended loops of the small intestine in the right upper quadrant due to adhesions. Hydroscopic fluid levels may occur in any case of intestinal obstruction due to a lesion in the small or large intestine.

Fig 4 (*lower left*) Full stomach film showing perfectly filled stomach and duodenal cap. The small intestinal pattern (except for the ampullary portion) presents a normal appearance

Fig 5 (*lower right*) Barium filled stomach in erect position. No hydroscopic fluid levels seen within small intestinal coils. The duodenal ulcer is faintly visualized

lesion in the small intestine" William H Stewart, in discussing this paper at its presentation before the American Roentgen Ray Society, stressed the importance of having patients x-rayed at frequent intervals between the time the stomach is filled and the six-hour study

Eusterman, Berman and Swan (10), in their paper published in 1925, report a careful analysis of 15 cases of duodenal carcinoma. Roentgen-ray examination was accomplished in 10 of these cases. In three cases, the roentgen findings were negative. In five cases, there was present a dilated

"the most important and constant x-ray finding is the gas and fluid distention of the bowel. The fluid may show hydroscopic Mills (18), in his classic paper on "Small Intestinal States," published in 1922, brought into focus numerous lesions of the

GRAPHIC CHART OF PERCENTAGE RELATIONSHIP BETWEEN
PRIMARY DUODENAL CARCINOMA; ALL INTESTINAL
CANCERS AND CANCER IN GENERAL

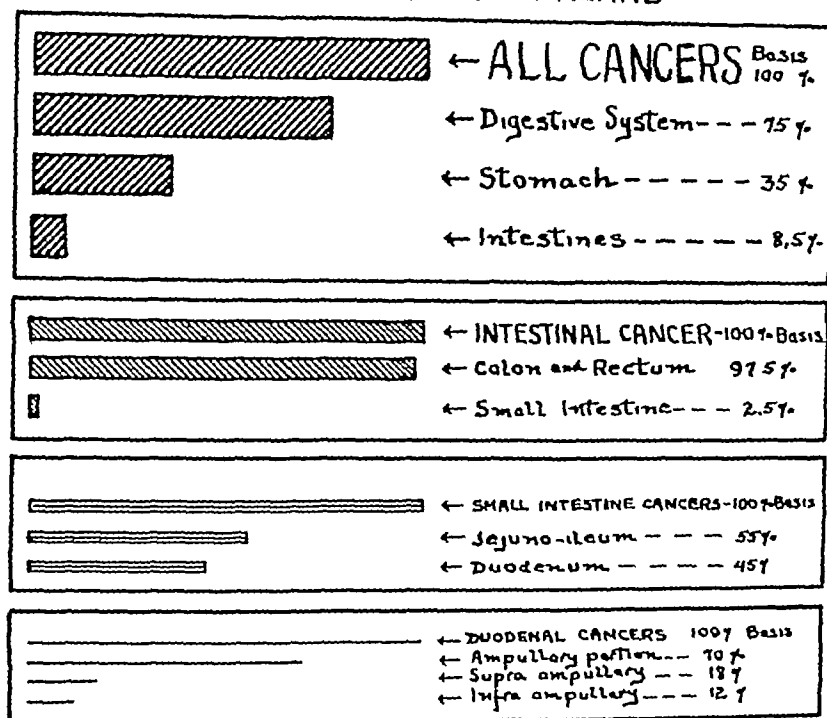


Fig 1

levels in the various loops [Figs 2 and 3]. The amount of gas, fluid, and distention will depend on the location of the lesion, it is greatest in the low obstruction." Herman and Von Glahm (11), in 1921, restudied the roentgenograms of a case of primary carcinoma of the supra-ampullary portion after the autopsy diagnosis had been made, and noticed a slender canal or "stalk" representing the stream of barium passing through the lumen of the duodenal growth. They believe that "a similar roentgen-ray picture in the future will be an aid to roentgenologists in the diagnosis of carcinoma of the supra-ampullary portion of the duodenum."

small intestine that can be diagnosed roentgenologically. The following extract is worthy of note: "Any organic process involving the small intestinal wall, either primarily or secondarily, will modify the x-ray shadow of the contents of the part involved and thus render direct diagnostic evidence of its presence, if not as strikingly as in the instance of stomach and colon or yet as suggestively as to the nature of the lesion, none the less positively as to an organic pathologic process being present." Accompanying this manuscript are numerous illustrating roentgenograms, but the author does not venture to make a definite diagnosis other than that of an "organic

small annular area of constriction about two centimeters in length. The lumen of the gut was constant in size and shape, and the irregularities of the surface are similar to those observed in carcinoma of the colon. The lesion was part of a general peritoneal carcinomatosis, and whether this was the primary lesion could not be determined at operation. The local lesion was not removed and, therefore, the gross or microscopic sections are not available." In Cole's book there is also incorporated a roentgenographic print of a carcinoma of the small intestine, interpreted as such by C. T. Baker.

I wish to report the following unusual and rare case of duodenal ulcer of the supra-ampullary portion of the duodenum, combined with an independent primary carcinoma of the ampullary portion of the duodenum, both of these lesions being clearly visualized in the roentgenograms (Figs 4, 5, 6, 7, 8, and 9).

CASE REPORT

N. C., a white male, aged 34 years, a chauffeur by occupation, was referred to my office by Dr. H. Rappaport for roentgenologic study of the alimentary tract. His family history, past history, and habits were unessential.

Present Complaint—The patient had experienced an insidious onset about one month before, with pain in the epigastric region one or two hours after eating, which was relieved by food and bicarbonate of soda. For the past two weeks he had suffered with "heart burn," with an acid taste in his mouth. He had lost 22 pounds in the past two months. He was constipated, he had no black stools. He had had vomiting attacks during the past ten days.

COPY OF X-RAY REPORT, AUG 5, 1935

Esophagus—The barium paste passes readily through the esophagus, meeting with no delay or obstruction. There are no evidences of cardiospasm, peptic esophagitis, or any organic filling defect.

Stomach—Not enlarged, orthotonic, in normal relation to the spine, and peristaltic

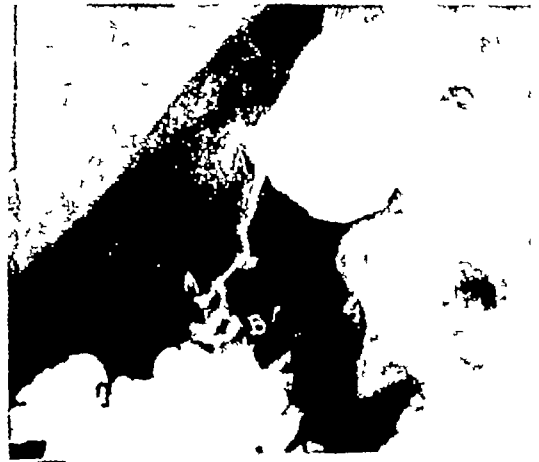


Fig 7. Roentgenogram showing the ampullary portion of the duodenum magnified. The region A-A presents a constant string like contour defect, with absence of valvulae conniventes. The valvulae markings of the infra ampullary portion marked (B) are clearly visualized.

activity is increased. Greater and lesser curvatures do not show any constant deformity or filling defect. Greater curvature is 4.5 inches above intercostal line in horizontal posture, and drops to 1.75 inches above intercostal line in the erect position.

Duodenum—The duodenal cap shows perfect filling ten minutes after swallowing the barium meal, but after a period of one-half hour, with "dosified expression and compression," a large ulcer is seen *en face*, apparently within the posterior wall. The ampullary portion of the duodenum presents a narrow string-like appearance, the same having a constant contour defect in all of the serial exposures. No valvulae conniventes are seen in this portion of the duodenum. No palpable mass or fixation is present in the first or second portions of the duodenum, but there is a moderate amount of tenderness. No hydroscopic fluid levels or dilated small intestinal coils are seen in the erect position.

Three-hour Study (Fluoroscopy Only)—No additional information was obtained.

Six-hour Study—A fleck of barium is retained in the crater of the duodenal ulcer. The stomach is empty. The barium meal is distributed throughout the large intestine and pelvic colon.

X-ray Diagnosis—(1) Ulcer of first por-

stomach with considerable barium residue without a demonstrable lesion. In two cases, the "demonstration of a large stom-

diographic Exploration of the Mucosa of the Gastro-intestinal Tract," published in 1934. They state that "pathologic lesions

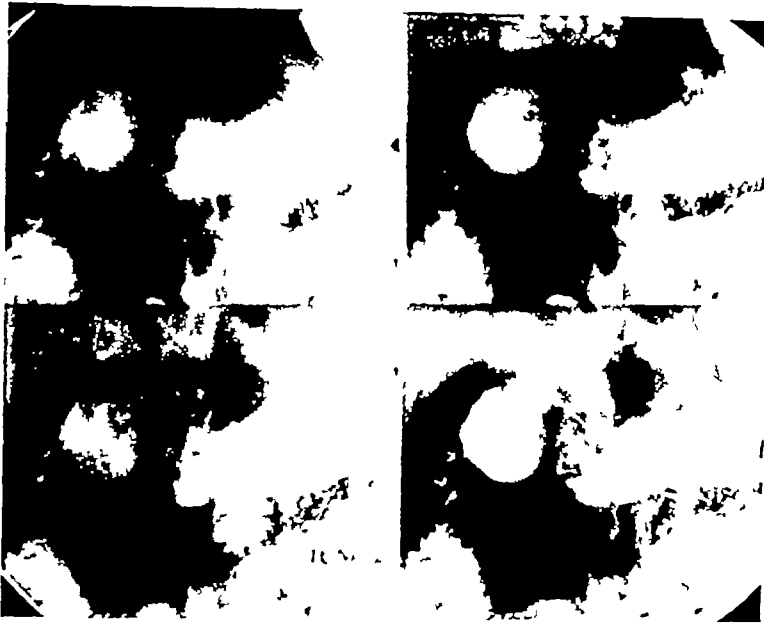


Fig 6 Serialogram taken 10 minutes after the barium meal was swallowed. The string like narrowed lumen of the ampullary portion of the duodenum is constant in all of the exposures. There is too much barium within the duodenal cap to visualize the ulcer.

ach, dilated duodenum, and retention made an exact anatomic diagnosis possible."

Soper (22), in 1929, emphasized the importance of making the exposures in the erect position. He also impresses us with the fact that primary carcinoma of the small intestine may simulate a duodenal diverticulum. In the former, there is generally a gas bubble surmounting the fluid level; its outline is of irregular character, the shadow is apt to be evanescent, and the occult blood reaction is positive. Among the lesions portrayed in the roentgenographic reproductions accompanying the article are three cases of malignant tumors of the small intestine. A pre-operative diagnosis of malignancy of the small intestine was made in two of these cases, based on x-ray findings and strong persistence of occult blood.

A Utopian publication is that of the Cole Collaborators (5) in their book titled "Ra-

diographic Exploration of the Mucosa of the Gastro-intestinal Tract," published in 1934. They state that "pathologic lesions of the small intestine have been considered to be so infrequent as compared with those of the stomach, cap, and colon, that they have not attracted the roentgenologist's attention. We have learned from bitter experience that unless one looks for these lesions he does not see them, even though there are definite roentgenologic findings present." In another chapter, "Four Fundamental Findings" for diagnosis of carcinoma are applied to the small intestine, namely, first, constant filling defect, second, loss of mucosal folds, third, loss of pliability of wall, and fourth, abnormal appearance of mucosal pattern. Cole mentions only two cases of neoplasm of the small intestine. One case was pre-operatively diagnosed as dilation of the duodenum caused by a small annular constriction about one or two centimeters in length. Biopsy disclosed a sarcoma at the duodenal-jejunal junction. The other case shown "was evidenced roentgenographically by a

GROSS EXAMINATION

Gastro-intestinal Tract—Esophagus is normal. The stomach contains a large amount of dark brownish-red fluid. The lining mucosa is normal. Two centimeters below the pyloric ring on the posterior mucosal surface of the duodenum, there is a large crater, 2.5 cm in diameter, which extends down into the muscularis of the duodenum. The walls of the crater are firm in consistency and grayish-red in color, the area surrounding it is light red in color. The floor is grayish-red. Running across the floor of the crater are two blood vessels, the superior walls of which have been eroded through. The ampulla of Vater projects into the duodenal lumen and is slightly firmer in consistency than normal. On cut section through the ampulla of Vater, it is firm and grayish-white in color. The rest of the gastro-intestinal tract contains a large amount of brownish-red material.

Pancreas—Is normal in shape and position; the head is much firmer and more resistant than normal. The lymph nodes at the head of the pancreas are from 0.5 to 1.5 cm in diameter, and are very firm in consistency. Section through these nodes shows them to be firm, grayish-white in color. On cut section through the head of the pancreas, there is seen a small 1 × 3 cm grayish-white area located against the posterior wall of the first portion of the duodenum. The rest of the pancreatic tissue shows the normal architecture. The region of the ampulla of Vater is slightly firmer in consistency than normal.

Liver—Is slightly irregular in shape, and weighs 1,640 grams. Scattered over the entire surface of the liver are numerous firm, light brownish-white nodules, 1 to 15 mm in size, surrounded by a narrow band of dark red. The rest of the liver surface is a normal light brownish-red color. On cut section, scattered throughout the entire liver tissue, are numerous light tannish-white areas 1 to 17 mm in size, surrounded by a thin margin of dark red. The central portions of these areas are very



Fig 9 Six hour study, showing a fleck of barium retained within the crater of the duodenal cap

friable and somewhat red-tinged. The remaining liver tissue is light brown in color.

MICROSCOPIC EXAMINATION

Esophagus—Section transversely across the esophagus shows areas in which the stratified epithelium is missing, and the mucosa contains a moderate number of polymorphonuclear and mononuclear leukocytes.

Duodenal Ulcer—Section through the wall and a portion at the floor of the ulcer shows the overhanging wall to consist of a dense fibrous connective tissue, in which are an accumulation of polymorphonuclear and mononuclear leukocytes in the submucosa and muscularis. The adjacent mucosa is normal. The floor of the ulcer consists of a slight amount of fibrous tissue, but most of the structure is necrotic. The floor of the ulcer shows some dense bands of fibrous tissue penetrating into the adjacent pancreatic tissue.

tion of the duodenum (not associated with pyloric obstruction) (2) Severe duodenitis of second portion of the duodenum,

first portion of the duodenum All of the four fundamental findings as depicted by Cole (5) are present in the ampullary portion

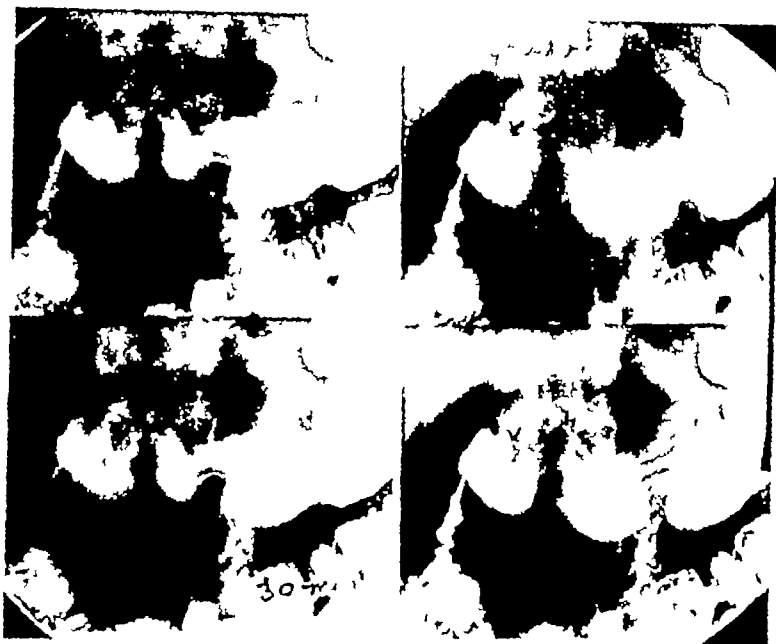


Fig 8 Serialogram taken 30 minutes after swallowing the barium meal, shows *en face* duodenal ulcer The narrowed ampullary portion of the duodenum is persistent

with possibility of a carcinoma of this portion of the duodenum

COMMENT ON X-RAY REPORT

Based on the x-ray findings, and with a history of considerable loss in weight, the writer at the time of the interpretation of the roentgenograms was convinced that he was dealing with a duodenal carcinoma in addition to a duodenal ulcer. However, due to the rarity of this combination, and in order to avoid the criticism of having made a fanciful roentgen-ray diagnosis, he reported the x-ray diagnosis as stated above. The opinion of "severe duodenitis" of the second portion was based on a similar string-like appearance seen in cases of ileitis (13) involving the terminal ileum. This also closely resembles the "stalk-like" barium shadow described by Herman and Von Glahn (11), in a case of carcinoma of the

Subsequent Progress of the Patient—On Aug 5, 1935, the day following completion of the x-ray examination, the patient went into shock, was rushed to the New York Hospital, and admitted to the service of Dr DuBois. Two blood transfusions were given with apparently very little beneficial effect. The patient died at 7 P M the following day.

EXTRACTS FROM AUTOPSY REPORT

Autopsy was performed by Dr Hall, on Aug 6, at 8 20 P M (Autopsy No 8219)

Anatomical Diagnosis—Chronic duodenal ulcer, rupture of branch of superior pancreaticoduodenal artery, with hemorrhage into stomach and intestines, and carcinoma of the greater duodenal papilla, with metastasis to the regional lymph nodes and liver

two and one-half to six-hour period following the meal, and exposures should be made at frequent intervals. The erect position is valuable for the demonstration of fluid levels within the intestinal coils, which are frequently associated with partial intestinal obstruction.

(2) The well trained roentgenologist should be capable of detecting an "organic" lesion in the small intestine. However, an attempt to specify the exact nature and site of the lesion is often a shrewd guess and may result in a fantastic x-ray diagnosis out of gear with that of the autopsy report.

(3) The presence of symptoms and physical findings suggesting gastro-intestinal malignancy (including absence of free HCl in gastric contents, and presence of occult blood in stools), *plus* the recognition of a small intestinal organic lesion roentgenologically, should spell a pre-operative diagnosis of carcinoma of the small intestine.

(4) Remember that the *correct* diagnosis of carcinoma of the small intestine has heretofore in the majority of cases been made either during the exploratory biopsy or at the postmortem examination. However, it is hoped that this symposium will encourage the roentgenologist to *look for* small intestinal lesions so that the percentage of cases diagnosed pre-operatively will be materially increased.

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Duodenum at Ampulla of Vater—The mucosa of the duodenum up to the ampulla is intact. The submucosa down to the muscularis consists of dense connective tissue, in which are groups and columns of moderate sized cells similar to those found in the liver tumor. The tumor tissue is separated entirely from the pancreas and has no relationship with the bile duct that is seen in this section.

Liver—In the liver, there are several circumscribed areas consisting of cells of moderate size that have an acidophilic staining cytoplasm, which in most instances do not have a definite outline, containing round and oval, mostly dark staining peripherally placed nuclei. However, a few of the nuclei are vesicular. For the most part, the cells are packed in groups, with no definite arrangement except in several areas in which the cells radiate around delicate connective tissue cords in which there is usually a small blood vessel. There are a moderate number of mitotic figures. One large area of the tumor tissue consists of a homogeneous dark acidophilic material, in which are seen a moderate number of dark staining and pyknotic nuclei. The surrounding liver tissue is compressed, and the sinusoids are filled with red blood cells.

Lymph Node at Head of Pancreas—This section consists of areas composed of dense bands of connective tissue, between which are groups of tumor cells similar to those described under "Liver" and areas in which there are mostly tumor cells with little connective tissue showing. In one large area, the connective tissue divides the tumor tissue into small cords and groups of cells. The adjacent portion of pancreatic tissue is similar to that already described, except that several of the islets show a slight amount of hyalinization.

Pancreas—One section of the pancreas shows an increase in both inter- and intra-lobular connective tissue. In the inter-lobular connective tissue septa, there is a slight increase in lymphocytes and large mononuclear cells. The other section of the pancreas, taken against the base of the ulcer, consists of a thick layer of connective

tissue in which are a few lymphocytes and large mononuclear cells. The rest of the section is composed of pancreatic tissue in which there is an increase in fibrous connective tissue.

DISCUSSION

This case is of unusual interest because of the following:

- (1) Rarity of duodenal carcinoma
- (2) Its independent association with a duodenal ulcer
- (3) The fact that both lesions are clearly demonstrable in the roentgenograms
- (4) Patient died from internal hemorrhage—an erosion of a blood vessel within the duodenal ulcer
- (5) There were no signs present of intestinal obstruction
- (6) Patient was 34 years old (Average age of cases previously reported is between 60 and 70 years)
- (7) Metastasis was present to adjacent lymph nodes and liver (Brill (2) states that metastasis even to the contiguous lymph nodes is not common)
- (8) Patient was not jaundiced (Eger states (8) that in cases of carcinoma of ampullary portion of duodenum, jaundice generally appears early)

ESSENTIALS FOR THE PRE-OPERATIVE DIAGNOSIS OF SMALL INTESTINAL NEOPLASM

As a result of this general survey, we should be impressed with the following important facts as to one's ability to diagnose primary neoplasm of the small intestine:

- (1) The roentgenologic study, if properly performed, is the strongest link in the chain of our diagnostic methods. The roentgenologist who follows the orthodox routine examination of the gastro-intestinal tract by studying the full stomach and then permitting the long interval of six hours to go by before doing the second examination, is sadly neglecting the investigation of two-thirds of the entire alimentary tract. To him, the small intestine is the "silent" or "blind" area. Abnormalities in the small intestinal pattern are best seen from the

and after the j^{th} dose

$$D_c = D \left\{ \frac{k_1 k_2 k_3}{k_3 k_4} \quad k_1 + \frac{k_2 k_3}{+ k_j} \quad k_1 + \right\} \quad (3)$$

This is a perfectly general expression for the cumulative dose. We have put no special conditions on the k 's except that they be greater than zero and less than one. When k_j is equal to unity, it means that the tissue is unable to overcome radiation effects. It is conceivable that the first few k 's might be equal to zero, if the dose D is very weak. The radiation effects are so small that the effects of the first few doses are completely washed away in the interval between doses. It must be emphasized, however, that each set of k 's depends on the size of D and the length of the interval between doses. In other words, each scheme of administering dosage will elicit a different reaction from the tissue. The k 's are a function of D and of the time interval T . We may write the functional relationship as

$$k_1 k_2 k_3 \quad k_j = f(D, T) \quad (4)$$

In order to discuss the variation of the k 's, it will be necessary to make certain assumptions about the power of recovery of tissue. The power of recovery will be dependent on the fraction of the total number of cells that are alive. There may be a complicated relation between this fraction of live cells and the recovery factor. For simplicity of calculation we shall assume in this discussion that the power of recovery is directly proportional to the fraction of the live cells in a tissue. If R is the coefficient of recovery, and S is the number of live cells out of a total of N cells, we have

$$R = c \frac{S}{N} \quad (5)$$

where c is a proportionality constant. The fraction of dose remaining in the tissue will be

$$k = 1 - R = 1 - c \frac{S}{N} \quad (6)$$

Thus when $S = 0$, $k = 1$, and all of the

energy of the dose, D , remains in the tissue. When $S = N$, that is, when all cells are alive, $k = 1 - c$, and the power of recovery is at a maximum.

We need not, however, think in terms of the live cells. We may use the fraction of cells which have not yet been "hit" by n photons. In order to calculate the fraction S/N we may utilize the statistical methods developed by Blau and Altenburger (6) and by Crowther (5). Suppose an idealized slice of tissue is irradiated by a beam of photons incident perpendicularly on the plane of the tissue. Considering the cells as independent individuals, the number of cells not yet hit by n photons will be, according to Crowther,

$$S = Ne^{-\lambda q} \left\{ 1 + \lambda q + \frac{\lambda^2 q^2}{2!} + \frac{\lambda^3 q^3}{3!} + \right. \\ \left. + \frac{(\lambda q)^{n-1}}{(n-1)!} \right\} \quad (7)$$

where λ is the probability of a hit for unit dose, and q is the dose, which may be written in terms of beam intensity, I , and time, t , as $q = It$. Since tissue is, by definition, a more or less homogeneous aggregate of cells, we may think of an average number of hits, h , required to damage a cell. If such an average for a given tissue is possible, Equation (7) is modified according to Zuppinger (and Meissner) (8) as

$$S = Ne^{-(\lambda q + h)} \left\{ 1 + \lambda q(1 + h) + \frac{(\lambda q)^2}{2!} \right. \\ \left. \left(1 + \frac{h}{1!} + \frac{2!}{h^2} \right) + \frac{(\lambda q)^3}{3!} \left(1 + \frac{h}{1!} + \frac{h^2}{2!} + \frac{h^3}{3!} \right) + \right\} \quad (8)$$

an expression which has been discussed by Braun and Holthusen (7). Equation (7) has received ample verification by the experiments of Packard (9) on *Drosophila* eggs, Braun and Holthusen's work on *Ascaris* eggs (7), Zuppinger's work on *Ascaris* eggs (8). Cantt and Spear (10) give curves for the decrease of the number of mitotic figures in tissue culture *in vitro* after irradiation with gamma rays, which have the general shape of the curve S/N

CONSIDERATIONS OF THE VARIABLE RECOVERY FACTOR OF TISSUE

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ABSTRACT

It is assumed that the recovery factor is some function of the fraction of the total number of cells which are undamaged by n quantum "hits" $Rf(S/N)$. The fraction S/N is assumed to be given by the probability distribution expression

$$\frac{S}{N} = e^{-\lambda q} \left\{ 1 + \frac{\lambda q}{1!} + \frac{(\lambda q)^2}{2!} + \frac{(\lambda q)^3}{3!} + \frac{(\lambda q)^4}{4!} + \dots + \frac{(\lambda q)^{n-1}}{(n-1)!} \right\}$$

which has been tested by extensive experiments on various biological objects. The fraction S/N is determined after each dose in the protracted dose technique, and the recovery factor calculated on the simple assumption that it is directly proportional to S/N . Cumulative dose curves are given

WHEN tissue is subjected to a series of doses of radiation given at regular intervals, it is frequently desirable for the radiologist to know how much dose has accumulated after a given time. Thus Reinhard and Goltz (1) have given values of the cumulative dose for different increments of dosage utilizing a recovery factor of 8 per cent per day, as determined by Stenstrom and Mattick (2) for x-rays of 0.16 Å effective wave length. Hoffman and Reinhard (3) have given methods of calculating cumulative dose in the protracted method of radiation over long periods of time. These workers, however, assumed that the recovery factor remained constant over the time of treatment.

Now, it is not unreasonable to suppose if a tissue is exposed to repeated assaults such as it receives in the protracted dosage technique, with the treatment extended over a long period of time, that its power of recovery will be diminished until eventu-

ally its constituent cells are powerless to overcome any radiation effects. When a cell is dead, the cumulative dose is equal to the total dose administered, in other words, we are putting radiant energy into an inert physico-chemical system.

As has been suggested by Holthusen (4), the process of recovery from radiation effects consists of two possible processes: in the first, the photo-chemical products formed are turned into their original compounds by a reversible chemical reaction; in the second, the photo-chemical products are removed from the tissue by mechanical means, presumably diffusion. One may think of this process of recovery from radiation effects as a "washing away" of the undesirable photo-chemical products. For the sake of generality, it should be added that by photo-chemical products we mean any type of molecule which has been put into an energy state other than that which it would have in the undisturbed tissue. This would include molecules, electrons of which are vibrating in higher energy states, or constituent atoms of which are in other than normal energy states, or those that have lost a photo-electron, etc.

We will now calculate the cumulative dose, D_c , for the general case. Suppose that the increment of dose is D and that it is administered at regular intervals in time. The fraction of the dose remaining in the tissue after the first interval will be $k_1 D$, where $0 < k_1 < 1$. The second dose is administered, and after the second interval the remaining dose is

$$D_c = \{Dk_1 + D\}k_2 \quad 0 < k_2 < 1 \quad (1)$$

After the third interval we get

$$D_c = \{[Dk_1 + D]k_2 + Dk_3\} = Dk_1k_2k_3 + k_2k_3 + k_3 \quad (2)$$

damaged after successive doses. In the first approximation we make the following assumptions

(1) The cells are not dividing rapidly. This assumption is consistent with the hypothesis that N remains constant

(3) A fraction of the cells damaged will recover in the interval between doses. Thus if d cells are damaged, then βd cells will recover, where $0 < \beta < 1$. The fraction β will, of course, depend on the dose D and on the time interval T . It

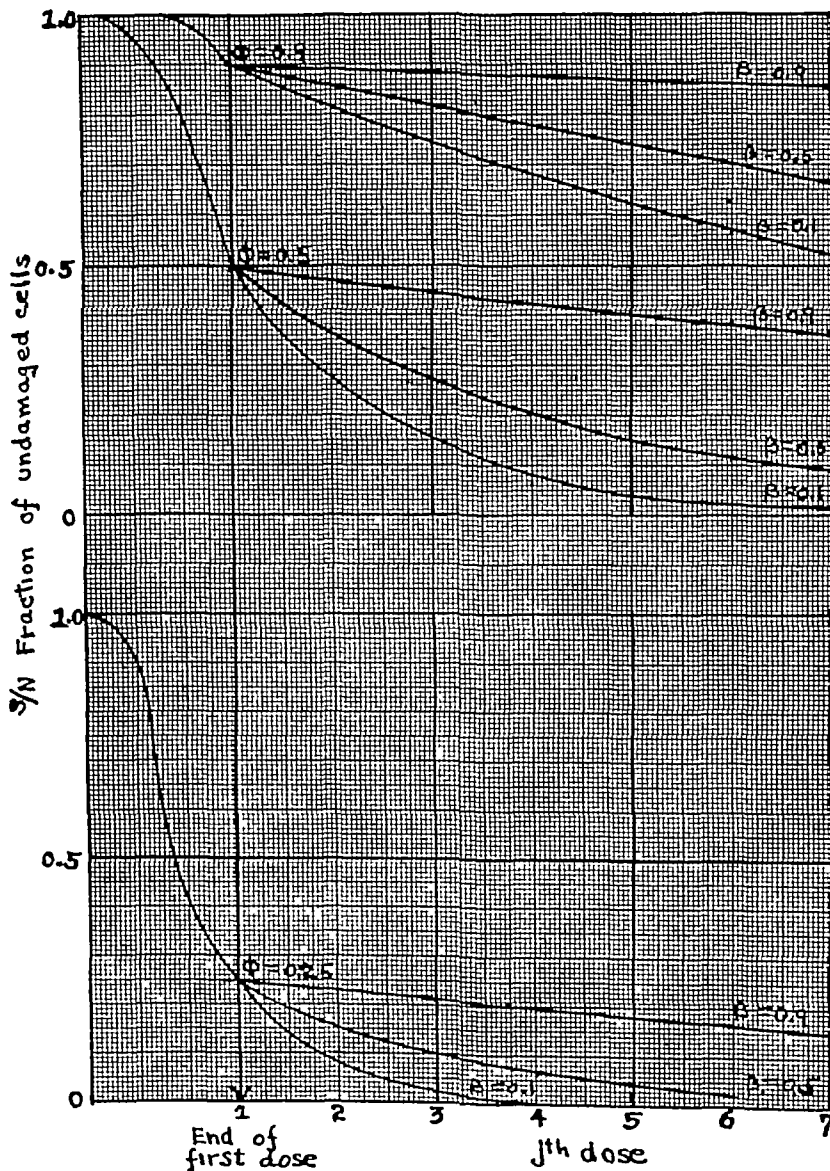


Fig. 3

(2) The probability, λ , of a cell being hit by unit dose is constant throughout the experiment. This is possible since N remains constant and the geometry of the tissue remains unchanged

may vary linearly or exponentially with T

Counting the "undamaged" cells, we get for the number of them after the first dose

$$S_1 = N\phi(\eta)$$

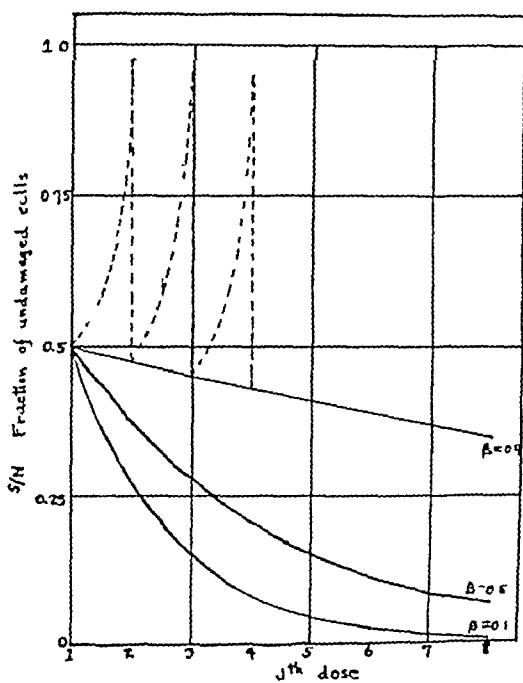
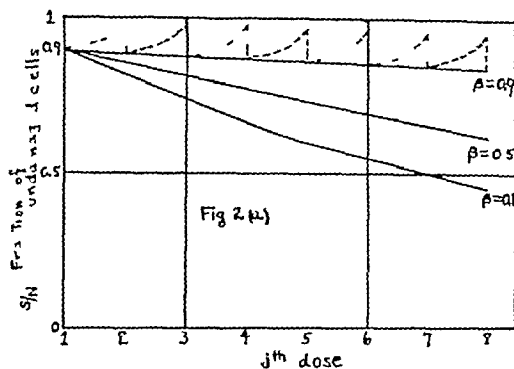
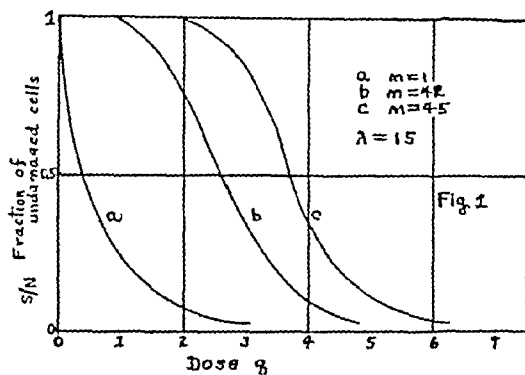


Fig. 2(b)

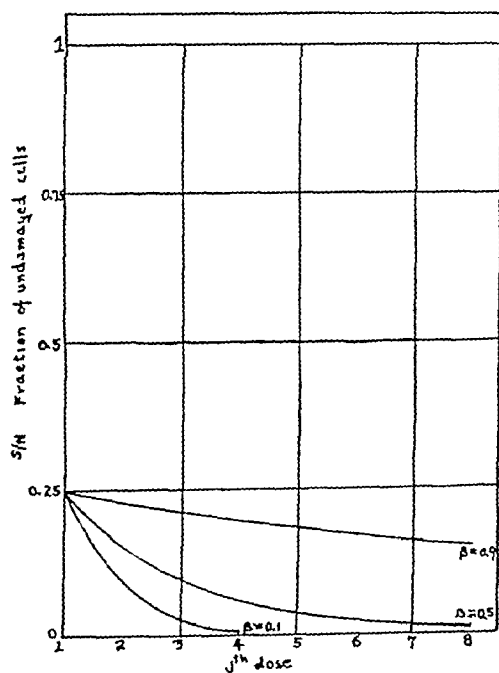


Fig. 2(c)

plotted from Equation (7). According to Crowther, the number of cells damaged by n hits in a dose q is

$$d = Ne^{-\lambda q} \frac{\lambda^n q^n}{n!} \quad (9)$$

For convenience we will write Equations (7) and (8) as

$$S = N\phi(n) \quad \text{and} \quad d = N\alpha(n),$$

respectively. It may be assumed that the

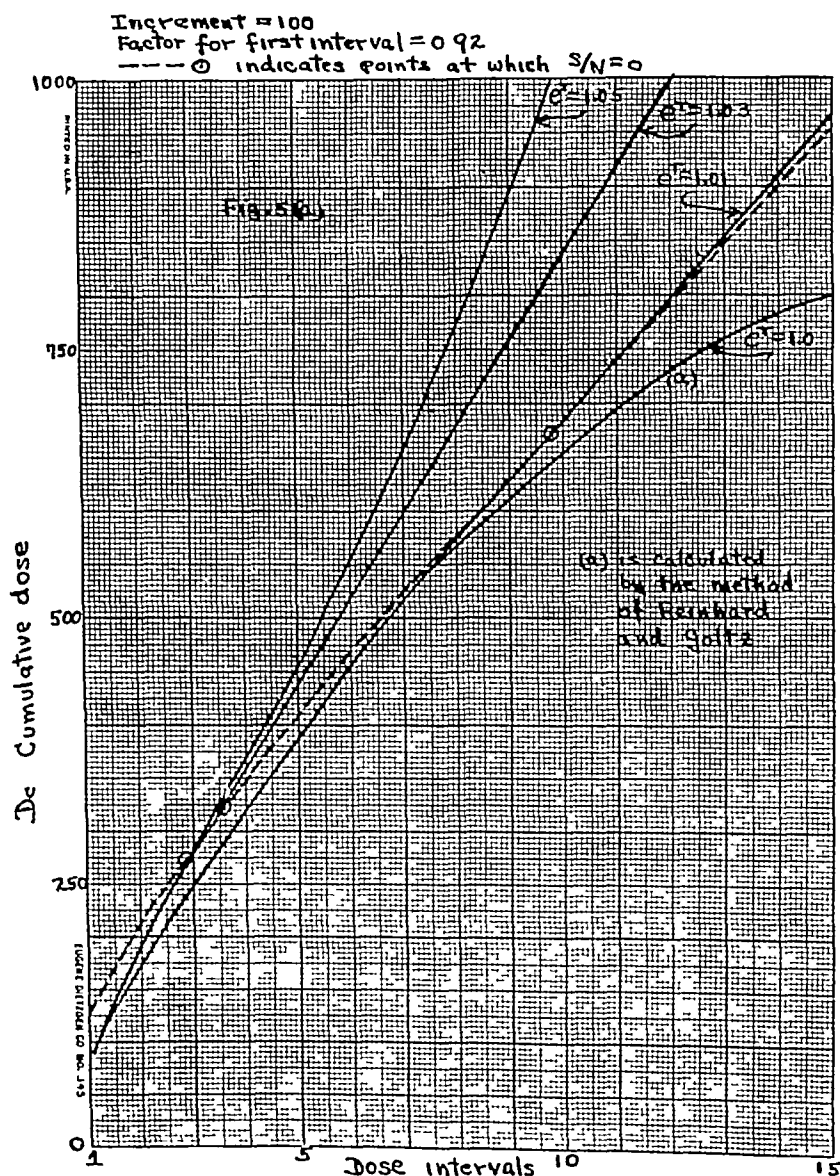
sum of the fraction of undamaged cells plus the fraction of damaged cells is unity. This places a unique condition on n . Theoretically it would be impossible to write

$$\frac{d}{N} + \frac{S}{N} = \phi(n) + \alpha(n) = 1$$

Yet for our purposes this condition will suffice in a first approximation. We may now calculate the number of cells un-

experiments of Braun and Holthusen (7) on *Ascaris* eggs seem to indicate that the magnitude of the quantum has no influence on the rate of mortality. They employed radiations in the range of wave lengths from ultra-violet to x-rays of 162 kv, 1 mm Cu half value. The theo-

and, consequently, the recovery factor may vary linearly (approximately) for high values of β , and pronouncedly exponentially for small values of β . This suggests a possible means of calculating the k 's in Equations (1), (2), and (3). Figure 4 gives a comparison of the function $y = a^x$ with



retical calculations of Mayneord (12), however indicate that an effect due to quantum magnitude is to be expected.

Figure 3 shows that the fraction S/Δ

S/N . The latter has been multiplied by two for convenience of comparison.

Assuming an exponential variation of the recovery factor, we will now calculate

and after the second dose

$$(\rho = (1 - \beta) \text{ and } \omega = 1 - \alpha(n)\rho)$$

$$S_2 = [N - d_1 + \beta d_1] \phi(n) = [N - d_1 \rho] \phi(n)$$

$$= [N - N\alpha(n)\rho] \phi(n) = N\omega\phi(n)$$

where d_1 is the number of cells killed by

against q for various values of n and λ , it gives Galton's famous ogival curves as shown in Figure 1. If n is large, there are few damaged cells for a small dose. If n is small, damage sets in very soon after exposure to radiation. In Figure 2 are

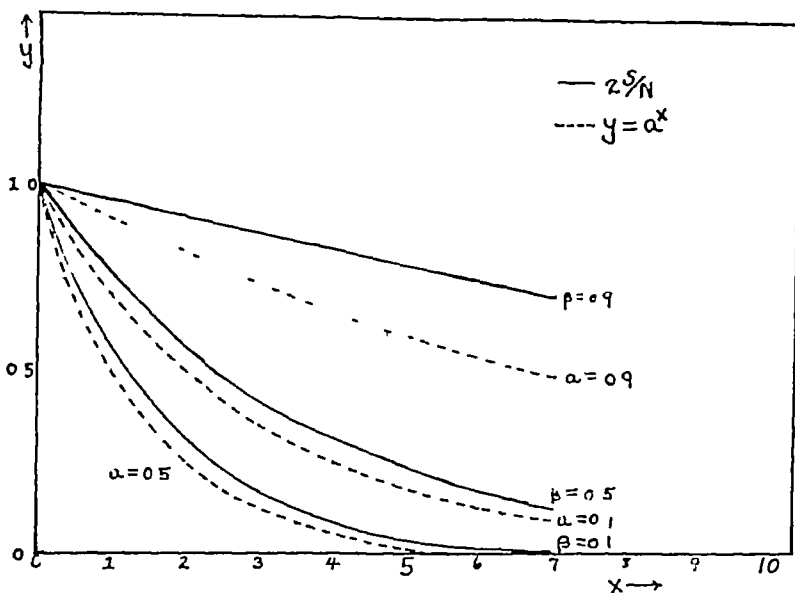


Fig 4

the first dose and βd_1 is the number that recovered in the interval between the first and second doses. For the number of cells undamaged after subsequent intervals we have, letting $\phi(n) = \phi$ and $\alpha(n) = \alpha$,

$$S_3 = [N - d_2 + \beta d_2] \phi = [N - N\alpha\rho - N\rho\alpha\omega] \phi$$

$$S_j = [N - d_{j-1}] \phi = \left\{ N - N\alpha\rho \frac{1 - \omega^{j-1}}{1 - \omega} \right\} \phi$$

or

$$\frac{S_j}{N} = \left\{ 1 - \alpha\rho \frac{1 - \omega^{j-1}}{1 - \omega} \right\} \phi = (1 - \alpha\rho)^{j-1} \phi$$

(for j doses, $j = \text{an integer}$) (10)

The function $S/N = \phi(n)$ has been discussed from the mathematical point of view by Condon and Terrill (15), it can be evaluated from tables of the incomplete gamma function (11). When plotted

shown values and the general trend of S/N for various values of $\phi(n)$, the fraction of undamaged cells, and β , the fraction of cells that recover in the interval. The dotted lines indicate the probable course of S/N , while the solid line indicates the apparent course as determined just after each increment of dose is administered. Figure 3 is a composite of Figures 1 and 2, and is an attempt to show the course of S/N beginning with the first dose.

Inspection of Figure 3 shows how widely the reaction of our idealized tissue may vary according to the different modes of irradiation it undergoes. The value of the function $\phi(n)$ is determined by the magnitude of the dose q ; it is also determined by n , which in turn would be a function of the quantum magnitude $h\nu$, where h is Planck's constant and ν is the frequency of the incident radiation. The

$R = c(S/N)$, c may be termed the recovery factor when $S/N = 1$, or the power of perfectly intact tissue to wash away the effects of radiation. R may be measured in roentgens per unit time. It is evident that c will vary with the rate of absorption of energy in the tissue. Once c is deter-

5- c assumes a value intermediate between 8 and 70 per cent, namely, 40 per cent for the factor in the first interval. The circles in each diagram indicate approximately where the ratio S/N becomes zero, that is, the point at which all cells are damaged by n hits. Beyond this point the cumu-

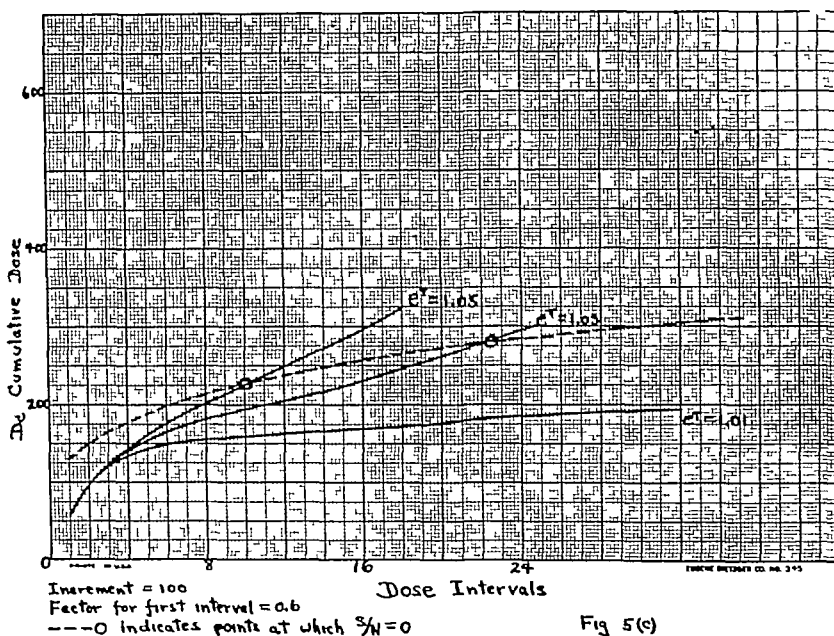


Fig 5(c)

mined, c_1 can be obtained from the relationship $c_1 = 1 - c$.

Figures 5, a, b, and c, show the course of the cumulative dose, for an incremental dose of $D = 100$ units. Figure 5-a assumes that the recovery factor for the first interval is 8 per cent as used by Reinhard and Goltz (1), or that 92 per cent of the first dose remains in the tissue after the first interval. This initial value is then varied exponentially according to the equation $k = 0.92e^{T_i}$ where $i = 1, 2, 3, \dots, j$, and T has values such that $e^T = 1.01$, $e^T = 1.03$, $e^T = 1.05$ etc.

These curves show the cumulative dose just before each increment is given. Figure 5-b assumes an initial recovery factor of 70 per cent as suggested by the work of Duffy, Arneson, and Voke (13), who found that skin recovers 69 per cent in 24 hours and 76 per cent in 48 hours for γ -radiation of 0.16 Å effective wave length. Figure

5-c assumes a value intermediate between 8 and 70 per cent, namely, 40 per cent for the factor in the first interval. The circles in each diagram indicate approximately where the ratio S/N becomes zero, that is, the point at which all cells are damaged by n hits. Beyond this point the cumu-

lative dose is merely the total dose since the tissue is no longer able to recover from radiation effects. The phrase "damaged by n hits" does not necessarily mean that the cells are dead or have actually suffered mechanical damage. To use the apt word first suggested by Crowther, the cells are in different "states". And the fraction S/N may be taken as an index of the state in which our idealized tissue is after the irradiation. The existence of such states is indicated roughly by Flaskamp (14), who gives a graph indicating reversible and irreversible states in terms of the skin erythral dose: there exist certain critical doses, which, if exceeded, put the skin in an irreversible state which leads to permanent injury. Crowther found that the organism, *Colpidium colpoda*, was able to recover from roentgen radiation in three hours on the average for moderate doses, but that if a

the cumulative dose which was given by

$$D_c = D \{ k_1 k_2 k_3 \dots k_{j-1} + k_1 k_2 k_3 \dots k_{j-2} + k_1 k_2 k_3 \dots k_{j-3} + \dots + k_1 \}$$

Since $k = 1 - c(S/N)$, we have for undamaged tissue $S/N = 1$ and

$$k_0 = 1 - c = c_1 \quad (12) \quad \text{and}$$

according to the usual processes of summation we get

$$T \sum_{i=1}^j X_i = T [j + \frac{1}{2}(j-1)] = \frac{T}{2} [j^* + j]$$

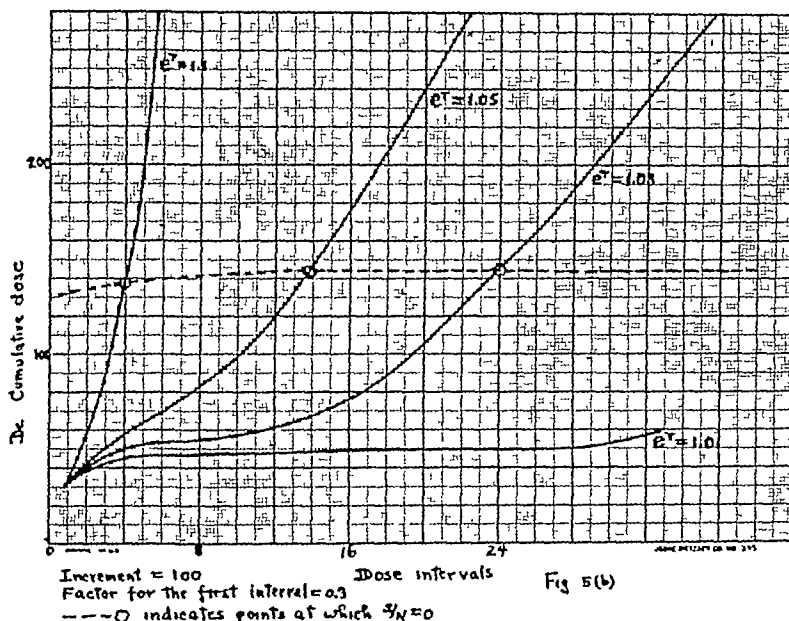


Fig 5(b)

If S/N decreases exponentially, then k increases exponentially, and we write

$$\begin{aligned} k_0 &= c_1 e^0 = c_1 e^{0T} \\ k_1 &= c_1 e^T, & k_2 &= c_1 e^{2T} \\ k_i &= c_1 e^{iT} \end{aligned}$$

Note that in order for these factors to have any physical significance, they must fulfill the condition that $c_1 e^{iT} \leq 1$. The expression for the cumulative dose becomes, on letting $i = 1, 2, 3, \dots$, take on integer values

$$D_c = D \left\{ c_1^j e^{\frac{j}{2} T} + c_1^{j-1} e^{\frac{j-1}{2} T} + c_1^{j-2} e^{\frac{j-2}{2} T} + \dots + c_1 e^{iT} \right\}$$

The exponents of e are sums of arithmetic progressions, while the series in the parentheses is a geometrical progression. Ac-

$$D_c = D \left\{ c_1^j e^{\frac{j}{2} T} + \dots + c_1 e^{iT} \right\}$$

The parenthesis can be shown to be equal to

$$\frac{c_1 e^{iT} - c_1^{j+1} e^{jT} c_1^j}{1 - e^{iT} c_1} = c_1 e^{iT} \frac{1 - (c_1 e^T)^j}{1 - c_1 e^T}$$

whence

$$D_c = D c_1 e^{iT} \frac{1 - (c_1 e^T)^j}{1 - c_1 e^T} \quad (13)$$

The constant c_1 can best be interpreted from a consideration of the following idealized experiment: tissue is exposed to radiation of such low intensity that the photo-chemical products are removed from the tissue by the normal processes of elimination rapidly enough to prevent their interfering with the life processes of the cells. Since $k = 1 - c(S/N)$, or

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-

certain value were exceeded the organism went gradually to a premature death

The curves of Figures 5, *a*, *b*, and *c*, were calculated for 100 units of incremental dose for convenience of presentation. The cumulative dose for any increment can be obtained by multiplying the ordinates of the 100 unit curves by the proper multiple of 100. Thus for 500 units incremental dose, the ordinates of the 100 unit curves are multiplied by 5. But, since the dose is larger, the dotted lines which give the points at which $S/N = 0$ will be changed. That the point at which $S/N = 0$ varies with the dose and recovery factor is shown by a comparison of Figures 5-*a* and 5-*b*. The slope of the dotted line is much steeper in the former. A noteworthy feature of Figure 5-*b* is that the dotted line is almost straight ($D_c = 144$), indicating that the same cumulative dose is required to produce the same biologic effect, but that the effect is attained after different times according as the recovery factor varies. When the recovery factor varies according to the equation $k = 0.297e^T$ where $i = 1, 2, 3, \dots, j$, the cumulative dose never crosses the line where $S/N = 0$. This would correspond to an irradiation which did not produce the biologic effect defined by $S/N = 0$.

In the foregoing calculations we have dealt with an idealized layer of tissue one cell thick. In practical cases one deals with three dimensional masses of tissue. The dose, g , for the different layers of tissue will be different on account of absorption of the radiation. Assuming the simple exponential law for the decrease of intensity with depth with appropriate scattering correction, and assuming a variable sensitivity throughout the volume of the tissue, it becomes a matter of integration over the volume to find the number of cells damaged by a given dose at the surface. Such integrations could be simplified by carrying them out over simple geometrical shapes such as the sphere, pyramid, cylinder, and prism.

We have assumed that the recovery factor is directly proportional to the fraction of the cells damaged, $R = c(S/N)$. In

general we should write $R = f(S/N)$. R may actually be proportional to some power of S/N , or may vary exponentially with S/N . We have taken the direct proportionality for simplicity of demonstration, hoping that the theory rather than any specific values may be of some interest. Moreover, we have not yet established a relationship between the ratio S/N and a standard biologic reaction, such as, for example, the skin erythema. Experimental and clinical data will have to determine the nature of the relationship $R = f(S/N)$.

Equation (7) gives the number of cells that have not yet been hit n times, it is derived on the basis that the N cells are independent of one another. Yet it is known that the cells of a tissue are not independent of one another. An added refinement in calculations with an equation of this type would consist in the use of the concept of "virtual hits". A given cell is affected by the actual hits on the other cells. These virtual hits would not necessarily have an immediate effect, but would exert their influence after a time interval depending on how quickly the disturbance is propagated through the tissue. The existence of these virtual effects would be taken care of by assuming a different value of n for each dose throughout the treatment.

If S_i denotes the number of cells undamaged after the i^{th} dose, and $\phi_i(n)$ denotes the probability distribution function which takes into account the virtual hits as well as the actual hits per cell, and β_i and d_i are the fraction of the cells recovering in the i^{th} interval and the number that are damaged by the i^{th} dose, respectively, our equations for the number of undamaged cells after each dose become

$$\begin{aligned} S_1 &= N\phi_1(n) \\ S_2 &= \{N - d_1 + \beta_1 d_1\}\phi_2(n) \\ S_3 &= \{N - d_2 + \beta_2 d_2\}\phi_3(n) \end{aligned}$$

$$S_j = \{N - d_{j-1} + \beta_{j-1} d_{j-1}\}\phi_j(n)$$

Calculations based on the method of varying n have yet to be made

the area for which he asked] All of these can qualify as experts, and will, I know, be glad and willing to testify that the treatment as indicated to me was conservative, well within safe limits, etc

"That Dr K T, of B——, was born in 1899, graduated from Medical College in 1921, was licensed to practice in M—— in 1921, poses as a dermatologist and is so listed in the A M A Directory He is a Fellow of the American Medical Association and his address is I know nothing about him, but if you want me to, I can find out something from our Counsellor for M—— You might write him yourself, sending a postage paid envelope

"Now as regards idiosyncrasy There are quite a number of decisions from high courts upon it Among some of these are those listed in MacKee's book, page 1267 of the second edition You should have this book

"I will be glad if what I have written is of some help to you, and if I can help further, be free to call upon me, but please pay the postage fully I had to pay postage due on your last one "

I heard no more about this case until I recently wrote to ask about the outcome, and received the following

"The case came to trial and a judgment was rendered for the plaintiff, based entirely on the judge's impression that a definite warning of possible danger should have been given to the patient This judgment was appealed and here an interesting incident took place, namely, that the court stenographer died before the notes were transcribed The appeal judges, therefore, gave as their opinion that a new trial was the fairest in this particular case

"At the new trial, before another judge, the same witnesses and evidence, the case was dismissed, the judge basing his opinion on the following fact—that the claim was outlawed by the local statute of limitations However, he went fully into every claim of negligence and gave the defendant 'a clean bill of health' on every point, with the added rider that the plaintiff and her witnesses showed a woeful lack of ve-

racity in both their claims and evidence

"Dr T, of B——, did testify, but his evidence was rather shaken and discounted by other evidence in rebuttal by my witnesses, particularly *re* his qualifications, as it turned out that he was a graduate of a very poor school and his other qualifications were of like character

"We did not use any of the witnesses recommended by you On the other hand, one of my competitors here was one of my best witnesses Dr P——, of M——, was my other radiological expert witness

"The case was reviewed in the March, 1935, issue of the Canadian Medical Journal, page 329, the synopsis being made by a lawyer for the Canadian Medical Journal "

Malpractice suits are not nearly so frequent in Canada as they are in the United States, and our Canadian brethren are to be congratulated upon winning this one, as one such case lost would be a signal to the legal profession that there was a likelihood of more of the same sort to be won One such case defeated is better than any number settled either out of court or tried and lost

NOT NECESSARY TO INTRODUCE ROENTGENOGRAMS?

A radiologist in the Southwest wrote me "Some time during the past few months, I recall seeing a court ruling, in which it held that it is not necessary to introduce radiographs, but the roentgenologist's expert testimony is sufficient I have an occasion to request that ruling through my attorney in a case in which I expect to appear very soon and want to give him the reference, but have not located it Knowing your special interest in the medico-legal aspects of radiology, I wonder if you recall the ruling, and if you can tell me where it can be found "

I replied as follows "Replying to yours of the 24th, will say that I do not remember having seen the recent case decision you mention, but having a nearly completed paper on this and allied subjects¹ on my desk, I can easily give you several refer-

SOME LAWSUITS I HAVE MET AND SOME OF THE LESSONS TO BE LEARNED FROM THEM

(Fourth Installment)

Bv I S TROSTLER, M D , F A C R , F A C P , Chicago

A CANADIAN (PRURITUS) SUIT

A RADIOLOGIST in eastern Canada wrote me, "May I presume on your good nature in stating a case and asking advice?"

"I am threatened with a suit as a result of a burn. The patient had pruritus and was given a dosage which appears all right, viz:

"March 3, 1931, 3 ma, 3 inch spark gap (kilovolt measurement), 10 inch distance, no filter, for five minutes' time

"March 21, in 18 days, she had another treatment for two minutes with the same factors

"April 13, 23 days later, I saw her and described in my notes an erythema which I thought was satisfactory

"July 2, 3 months later, another physician saw her with an ulcer on the left buttock

"Sept 2, 1932, to-day, several physicians (my friends) state that the healed appearance of the region about the anus is that of an x-ray burn

"The thing that suggests itself to me is that she received some further x-ray treatment elsewhere, but that is only conjecture and incapable of proof by me

"Would it be too much trouble for you to suggest possible lines of defense?"

"Could you give me your opinion on the question of idiosyncrasy? And quote me authorities?"

"Could you suggest any especial medical x-ray authorities in the eastern United States, who might be willing to appear as expert witnesses? I feel sure that I would have the absolute support from Canadian x-ray men. The opposition is getting a Dr K—— T——, from Boston

"The main reason I am writing you is that I know of your great interest in the medico-legal end of our specialty, and again, in Canada there is very little prece-

dent, either legal or medical, upon which we can call

"Thanking you, Doctor, in anticipation," etc

I replied "Replying to yours of recent date, will say that if your laws regarding medical malpractice are at all like ours, you should have little or no difficulty in getting a non-suit, and the case taken from the jury by the presiding judge, because you can immediately show that your treatment was not in any sense or possible way malpractice or wrong in any way

"If you have 'X-Rays and Radium in the Treatment of Diseases of the Skin,' by George M MacKee, second edition, 1927, and will refer to page 259, you will find a table of dosage for 3 inch spark gap technic for 8, 10, and 12 inches and for 2 and 3 milliamperes

"The technic you used—10 inch distance, 3 inch s g, 3 ma, for 5 minutes—will produce just short of 43 per cent of an E S D, while your second application administered 18 days later, of 2 minutes at the same technic, will produce exactly 17 per cent of an E S D, or a total of just short of 60 per cent of an E S D over a period of 18 days. If that produced even an erythema, either your measurements are wrong or the patient had a marked idiosyncrasy

"I do not know how your laws are, but if there is an opportunity to introduce MacKee's book in evidence, and I know how I could do that, *that table*, even if they do not allow the introduction of books, there should be no trouble in getting a directed verdict, even if the case was allowed to go to the jury

"You ask me for the names of competent experts in New England. The nearest one is a woman physician, whom I am sure can put it over for you. [Here I cited the names and addresses of six physicians in

me to give my opinion upon, when you say 'testimony quoted by attorneys from the author, was ruled out,' etc

"If you mean the reading of medical books to the jury, as evidence for the purpose of influencing that jury, I would say that there are plenty of references to indicate that 'the contents of scientific books cannot be read to a jury for the purpose of establishing the facts or establishing the deductions stated in them' (See references at end hereof)

"Another aspect of this situation is that, 'It is well established (according to several New York State high courts), that a party calling an expert witness cannot read from medical works on inductive science and ask his expert if he agrees with the statement of the author, or if it accords with his experience' (See references 6 and 7)

"But to all this, there are notable exceptions and *by very good and highly respected authorities* (See references 3 and 4)

"On the other hand, when it comes to cross-examination, an entirely different rule applies. During cross-examination, the qualification of an expert witness may be established 'in any way which will enable the jury, who are to pass upon the weight to be given to his testimony, to judge intelligently about it' (See reference 1) It is permitted and considered permissible in some States in this country to call the attention of expert witnesses, during cross-examination, to medical books and to ask them if they agree with the authors. This is, of course, not done for the purpose of trying to make the contents of the books into evidence but is usually done for the purpose of belittling the witness and of minimizing or reducing the weight of his testimony. The degree and extent to which attorneys may go in such questioning depend much (if not entirely) upon the presiding judge

"I note what you say about my feeble efforts to bring medico-legal information to the readers of RADIOLOGY. I have had many complimentary letters about it and know my efforts are appreciated. We do

not know enough about this important subject

"While on the subject of the introduction of medical books and questioning expert witnesses, in cross-examination, to belittle and reduce the weight of their testimony, I am reminded of an instance in which this was being 'worked' on me. While holding a big, formidable looking book in his hand, a very prominent attorney asked me if I agreed with what the author said about the subject of my testimony. Being on my guard against some trick or subterfuge, I said I was unable to state, until I saw the book more closely. The lawyer pompously handed me the book, and, upon opening it at the title page, I discovered that it was more than twenty years old. Handing the book back to the attorney, I said that practically no medical book as old as the one he had in his hand was considered to be worth the paper it was printed upon. He hurriedly laid the book upon his table and started another line of questioning. In re-direct examination, I was asked about how old the book just mentioned was, and when I said more than twenty years, I could see by the expression on the faces of the jury that my testimony 'went over' with them. I gave out the impression that the big attorney was trying to trap me and that I not only could not be trapped, but trapped him. Juries enjoy such things as well as any, if they have the I Q. to appreciate them.

"If this is not the information you want, make it just a little clearer and I will see if I can furnish it."

A CHICAGOAN'S ACNE CASE

The attorney for an insurance company sent a young woman to see me, whose attorney had threatened suit against a young Chicago physician for malpractice in the application of the roentgen rays in the treatment of acne on her face.

The claimant had had acne for about five years and had received twelve applications of the x-rays. The first four were 3 minutes, at 15 inches F S D, and the last eight were 12 minutes with the tube at 10 inches

ences which I am sure will serve to put you in the position you apparently desire to be

"Interpretation of a roentgenogram which was lost and, of course, not in evidence, was admitted in *Speilmeyer vs Hertz Metal Co*, 272 S W R, 1068

"A similar decision was rendered in a case in which the witness was a chiropractor, in *Bachman vs Quincy and K C Ry Co*, 274 S W R, 761 (a Missouri case)

"*Quinn vs Flesher*, 102 S E R, 300, and *Marion vs Coon Construction Co*, 110 N E R, 444, also point that way. The last-named case is a very important one and well worth reading

"On 'the other side of the fence,' *Lefebure vs Western Coal & Mining Co*, 285 Pac R, 450, specifically states that 'An expert witness may not testify as to what a roentgenogram shows, when the same is obtainable and not in evidence.' This is an interesting case

"If your attorney or you come upon the case you had in mind when you wrote me, *or any others along the same line*, I wish that you would give me the citations for my files. I am very much interested in that particular subject."

Although the above letter was written nearly two years ago, I have not had a line from my Southwestern friend. Like many others, perhaps he is too busy to write, *except when he wants something*. I sometimes wonder whether it is worth while for a fellow to acquire a reputation on some subject. I am asked questions like the foregoing, from four to six times every month, and the time spent in digging out the answers amounts up considerably. If the ones benefited would even as much as thank me for what I do, I would not care, but some of them seem to think that it is my duty to do these things. Perhaps it is, but Well, anyway, I suppose I will keep on doing it as long as I live. I have always been a sort of "ask George" sort of fellow, and probably would miss it if I was not asked

¹ The Legal Aspects of the Identification and Interpretation of Roentgenograms. I S Trostler. *Am Jour Roentgenol and Rad Ther* November 1934 32 680-693. Reprints furnished at 12 cents each

A SUIT INVOLVING A RADIUM TREATMENT

Ten years ago I was consulted relative to the defense of a malpractice suit, wherein an Illinois physician in treating a pigmented hairy nevus on the elbow of a three-year-old child, applied 115 milligrams of radium screened with 1 mm of silver(?), 1 mm of copper, 2 mm of rubber and five or six thicknesses of gauze for two hours (230 milligram-hours), according to the records of the defendant physician

It was alleged that a violent reaction followed, with a marked arthritic involvement of the child's elbow and considerable permanent disability and deformity as the end-result

I advised stalling the trial along as long as possible, by means of the various methods so well known to the legal profession, with the idea that if any injury had been done, the natural recovery of tissue and particularly in joints in children, would at least minimize the degree of involvement, and thereby lessen the likelihood of large damages being assessed

The parents of the child had brought suit for \$25,000. After stalling along for two years, it appears that the defendant's legal counsel were unable to secure any more continuances, and the suit finally settled for \$5,000, which, as far as I could learn, was more than the real damages were worth, as I was informed that the child's elbow was coming rapidly back to nearly—if not quite—normal

READING OR QUOTING FROM MEDICAL BOOKS, AS TESTIMONY

A far Western radiologist who had practised in Chicago became involved in a suit wherein certain medical books were referred to while he was on the witness stand. He wrote asking me about "testimony quoted by attorneys from the author of books, which was ruled out by some Superior Court, as being hearsay testimony and not admissible."

I wrote him in part as follows: "I am not sure that I understand exactly what you want to know, or, rather, what you want

showed the Doctor a letter which I had received from a radiologist, relative to a similar case, from which I quote the following 'Mr came to me June 16, 1928, with a history of pruritus of five years' standing I gave him 75 kv , 1 5 minutes, 5 ma , at 12 inch distance and no filter This same dose was repeated on the 23rd and on July 6th I usually treat these cases every week or ten days and continue the treatments several times after all the symptoms have disappeared I felt at the time that I was treating Mr that he should really have several more treatments, but he did not feel inclined to have them These cases are usually very stubborn,' etc

"After reading this letter the Doctor (plaintiff) asked that I give the same treatment to him Four such treatments were given in this series and each time the Doctor came in, I called his attention to the reddened condition It is interesting to note that our stories do not agree relative to the time that this redness appeared I maintain that it was there before the last four treatments in 1929, while the Doctor insists that they did not know of its existence until after the last four treatments were given He states that he visited Dr O at that time and was informed that he had a telangiectasis caused by too much x-ray My recollection is that he visited Dr O after we had completed our treatments in 1924

"All went quietly and we had dismissed the matter from our minds when, on Sept 18, 1931, the Doctor came to me, stating that he had to have something done and asking me to let bygones be bygones and that he was willing to take the responsibility of future treatment, and to say that Dr O was mistaken in his diagnosis

"After giving two more treatments I again called the patient's attention to the unsatisfactory condition and suggested that he consult some specialist, as I was not satisfied about continuing to give him x-ray treatments He (plaintiff) suggested that lack of results was due to insufficient exposure, so we decided to extend the time in the last four treatments This was under

protest by me, but insisted upon by the Doctor, and was supplemented by various medication, sitz baths, etc

"It is hardly necessary for me to say that had I followed my better sense of judgment in this case instead of the Doctor's orders, no treatments would have been given after the first eleven I might add that the same technic as used in the last four treatments has been used on other cases with good results and no ill effects, which, of course is not much consolation as far as the Doctor's case is concerned

"This is a long story and I assure you that we are always glad to learn of a new and better technic in connection with x-ray work "

I replied immediately as follows "I am sorry to say that I most strenuously disapprove of the treatment you administered and do not believe that you will be able to find a roentgenologist of experience and reputation, or one of any standing in radiology at all, who will be willing to go on the witness stand and testify that it was good therapy, or properly administered x-ray treatment

"Your repeated application of unfiltered radiation in this case is contrary to what I personally have for many years been harping against, and while quite a number of dermatologists still apply a considerable number of unfiltered treatments, none of them would dare apply as much at each time as you did There is no question in my mind but that you administered too much radiation during 1922 and 1924, and that, while the amount in 1929 and 1931 were probably not enough to damage a normal skin, it was probably enough to seriously injure the already insulted skin

"So, reasoning from the above premises, as I see things, the only useful defense that you can have will be that the patient, a graduate and licensed physician, prescribed the treatment, and all you did was to fill his prescription In other words, the patient, acting as his own physician, assumed the relation of principal and you assumed the position as his agent If that can be presented to the attorneys, or to the court

F S D , all unfiltered and little known of the voltage or milliamperage The fee paid for the course was \$250 00

I reported as follows "*In re* L——N—— vs Dr N——T—— Pursuant to your instructions, I have examined this prospective plaintiff and hereby report

"I find that there is at this time a condition known as telangiectasis, accompanied with beginning skin atrophy on both cheeks—involving the mesial areas of both cheeks, the upper lip, the lower lip, the lower edges of both nasal alæ, the nasal septum (externally), and the anterior aspect of the chin There is also some considerable induration and irregular scarring in these areas, most of which are on the chin, and cheeks The vermilion surfaces of both upper and lower lips are also involved in this change

"While some—an indeterminate part—of the roughness and induration in the involved areas may be due to the fore-running acne, for which this girl was treated, there is absolutely no question that by far the greater portion of it was produced by overdosage of the roentgen rays

'The prognosis in this case is in my opinion about as follows The telangiectasis will become more marked and the skin atrophy, which is now only in the beginning, will progress and become more evident in a year or two *There is definite danger that this girl may develop malignant disease in the involved area*

"She informed me that the last roentgen-ray treatment was administered in September, 1931, and that she was not twenty-one years old until January 29, 1932, and I have no doubt that this is the truth In other words, she was a minor or legal infant until the last-named date (four months ago) This may have some bearing on your disposition of the case

"There is no question but that the treatment administered to this patient was the grossest of error and that she has been irreparably damaged Likewise, there is no question that her appearance at this time is decidedly better than it will be in a year or two from now

"I believe that I have given you the information you asked for and will need in disposing of this case If more is desired, or I can be of further service regarding same, command me "

The insurance company paid this patient \$2,000 and, if I am any judge of the matter, will say that they got off cheaply The young Doctor was not paying the additional fee rate for the use of the x-rays at that time I understand that he is not now treating by means of the x-rays His father, also a physician, sent me a patient for roentgen therapy about a year later

A TECHNICIAN TREATED A PHYSICIAN'S PRURITUS

A technician employed in an x-ray and clinical Laboratory conducted by a physician was one of the co-defendants with his employer, because of his (the technician's) x-ray treatment of a pruritus upon the person of another physician He wrote me "Pursuant to our conversation of January 24, I am enclosing information relative to the x-ray dermatitis case in question To the best of my knowledge, conditions in this case are as follows

"On October 26, 1923, the Doctor (plaintiff) came to me requesting that I give him the following exposure, 5 minutes, 5 inch spark gap, 5 ma, 12 inch target skin distance and no filter This prescription was carried out as carefully as I was able to measure same A total of eleven such treatments was given, as indicated on treatment slip (the ten applications were given in exactly eight months at about equally divided intervals)

"During this series of treatments no erythema was in evidence although careful examination was made prior to each treatment No treatments were given from June 25, 1924, until March 21, 1929, during which time frequent local drug medication was used by the Doctor When he returned for treatment on the last-named date, I called his attention to a marked redness about the anus, which appeared as though it had been severely scratched

"Before resuming x-ray treatment, I

technician, to operate the same. The physician has no knowledge whatsoever regarding roentgentherapy and his brother—the technician—knows only how to throw the switches. No records of voltage, time, FSD, or milliamperage were kept and they knew nothing about filters—in fact, they had none. In addition to their not having records, even the dates of the application of the radiation treatments were indefinite.

A large number of applications of unfiltered radiation were applied to the backs of both hands of the plaintiff, in the treatment of a chronic eczema, with the result that much damage was done.

I was consulted by another physician and the defendant's attorney regarding my appearance as an expert witness and the planning of a defense, and apparently to their great surprise, I declined to testify or offer them any plans leading toward a successful defense.

This was one of the worst instances of the misuse of the roentgen rays that I have ever seen, and I could not see my way clear to mix into it in any way. It was one of the far too numerous reasons why many otherwise intelligent people fear to have x-ray therapy applied, when such therapy is needed and most applicable for their trouble.

Investigation proved to me that it was merely an example of cupidity on the part of the pair involved in the application of the treatment. They had heard, or had been told by an apparatus salesman, that much money was to be made by owning x-ray apparatus. They had bought same and used it whenever and wherever the opportunity presented itself. In fact, they made the opportunities.

The case was settled out of court for \$4,000, which was cheap enough, at that price.

ANOTHER ECZEMA CASE

Eczematous skins appear to suffer more from roentgen ray injuries than do any others. At least your relater hears about more such instances—wherein patients who

have eczema have injuries and the physicians who treat them get into court because of them—than of any other group of skin diseases.

Eczema is a very common skin disease, and it may be because of this and that our radiation therapy is known to be beneficial in eczema, which accounts for the number of cases of treatment of eczema that get into court.

In 1930 I received the following letter: "I have been reading some of your articles on expert testimony and medico-legal cases from time to time, therefore I am writing you regarding a suit which I have pending. The case is one of alleged x-ray burn following a course of treatments given by me. The secondary changes apparently did not develop until fully a year and a half following the last treatment and I have been advised that keratoses with a few areas of malignant degeneration have developed over the area treated. There is, however, another factor that entered into the case, namely, a self-administration of arsenic in the form of Fowler's solution over a long period without my knowledge, so you see there is an opportunity for a difference in opinion and possibly expert testimony."

"Along about last January at one of our medical meetings at S. C. I heard a Dr. P., of Chicago, give a talk on various types of neuritis and one of the types which he very carefully elucidated was that of arsenical neuritis in the hands. The claimant in my case claims loss of strength, etc., in the hands and fingers. I wrote Dr. P. some months ago relative to this matter and he answered me rather unsatisfactorily, although I believe he stated that most of such findings had been worked out by his associate."

"I am wondering if you get a slant on my situation and if you would care to write me what you think about it. I may also state that the M. P. Co. will defend, but it may be that we should have some expert testimony. Anything you write will be appreciated by me."

My reply was as follows: "In reply, I will say that without more complete infor-

and jury, and the fact that a principal is always responsible for the acts of his agent, you and your employer may be released from responsibility. Personally I think that this can be done, fortunately for you and Dr G.

"While I have no right to scold you, much as I think you deserve it, I cannot help saying that in my opinion, you should *never* administer any treatment until some physician gives you a prescription or formula for the case or patient to be treated. If you do that, you will be on the safe side, and whoever writes the prescription will be responsible."

I heard nothing further for nearly four years, when, upon inquiry from the employer (physician defendant), he wrote "The suit you mention in which a fellow physician was suing me for damages for the small sum of \$50,000 was withdrawn by him. The only agreement that I made was that I would not sue him for damages. No money was paid. As the case did not go to court, I could not tell you just exactly what the defense would have been but it would probably have been on the basis of master and servant—the patient in this case being the master and my technician the servant, as you outlined. Thanking you for your kindly interest and advice to my technician," etc.

This suit was the third of a similar kind, in which a physician insisted upon having treatment which ultimately damaged and injured him, and wherein I was able by the presentation of the principal and agent defense, to secure the withdrawal of or prevent the filing of suits against the agent by the principal. Admitting that this may not be a nice thing to do, we must also realize that malpractice suits are not nice, and, from my way of thinking, practically any means or method of defeating them is and should be considered justifiable. I repeat, *malpractice suits are not nice*, at any time or in any sense, nor are they to be defeated by niceties. They require hard-boiled tactics, and when one has been in the fight against them as long as has the writer, one cannot help becoming pretty obdurate and repellent regarding them.

FORTY-EIGHT UNFILTERED ROENTGEN-RAY TREATMENTS

A middle-aged man, complaining of a chronic eczema on the backs of both his hands, received the following from a Chicago dermatologist according to the dermatologist's records: 7 treatments from a gas tube in 1919, 8 treatments in 1923, each of which was reckoned to be one-fourth skin unit according to the formula

$$\frac{\text{ma} \times \text{min} \times \text{SG}}{\text{distance}} = \text{dosage}$$

In 1924 the patient received 30 applications of one-fourth skin unit each and in 1925 three more of the same intensity. *All of these were unfiltered.*

A few months following the last application (in 1925), this patient consulted a very prominent dermatologist, and was informed that he had received "x-ray burns." Somewhat later he visited a well-known clinic, where again he was informed that he had "x-ray burns." Shortly thereafter he brought suit against the dermatologist who had administered the treatment, and in 1928 I was consulted relative to helping outline a defense and assisting in the trial of the case.

After I had learned the particulars, as related above, I informed all concerned in the affair that I could neither testify that the treatment was correct and proper, nor could I even suggest any adequate or useful defense for the case. I told them that "*it just ain't*."

The plaintiff's attorneys were unable to induce any physicians to testify for them, but managed to induce an apparatus sales man from a neighboring State to testify. They paid him \$100 for his services but he repented his action for a long time, and told me afterward that he would not do it again for \$10,000.

The trial resulted in a verdict for the plaintiff, which was later settled for \$3,000.

X-RAY THERAPY—AND HOW!

In a recent suit for malpractice in Chicago, the physician defendant owned x-ray apparatus and employed his brother as

BRONCHOLITHS AND STONE ASTHMA

By EUGENE P. PENDERGRASS, M D, and ALFRED A. DE LORIMIER,¹ Capt. M C,
U S Army, Philadelphia

PULMONARY calcifications interested Aristotle. Perhaps, previous to his time, and certainly since his time, they have fascinated the minds of generations of medical investigators (14, 11, 1, 18, 20, and 12). Many of the notations have essentially been that of amazement. Long before biochemical analyses came into usage, post-mortem observers marveled at man's ability to form stone in the soft tissues. But even since the advent of biochemistry, our insight into the processes by which calcareous depositions occur has proven very limited. In fact, our knowledge has practically been restricted to mere considerations as to where these concretions are likely to develop and, to some extent, when they are likely to form. The biogenetic nature of their development is not known. Wells tackled this problem (21). He differentiated the terms "calcification" and "ossification," but nevertheless he concluded that "there seem to be no essential differences between the processes involved in normal ossification and in most instances of pathologic calcification, any area of calcification may be changed to true bone in the course of time." Brown's analyses (2) of pulmonary concretions revealed percentages of inorganic constituents very similar to those of true bone.

As far as the lungs are concerned, calcareous deposits may be located, originally, in (1) the lung periphery, in contact with the pleura, (2) the lung parenchyma, regional to the bronchial tree—either localized to one or a few patches, or diffusely sprinkled throughout, (3) the lumina of the bronchi or bronchioles, and (4) the draining lymphatics. Pathologists are prone to associate, in most of these cases, a preliminary stage of tissue degeneration or

tissue necrosis. A tuberculous background is most frequently considered. However, other types of infectious processes, including pneumonia, bronchiectasis, abscesses, and infarctions, might be responsible. In cases in which the concretions are primarily formed in the bronchial lumina, aspirated foreign bodies are frequently the basis. At first, some of these are ray-transparent, later becoming calcified, others, such as rhinoliths, tonsilloliths, or dental calculi (15), are sufficiently opaque, by themselves, to produce a shadow, roentgenographically. Silicotic or anthracotic material might also be included in these categories (8). When a sprinkling of calcification is found throughout the lung parenchyma, biochemical bases must be considered. As long ago as 1885, Virchow (20) noted that the lung, the stomach, and the kidney were sites prone to calcifications. Wells (21) attempted to explain these observations on the grounds that such are "places in the body where acids are excreted"—in the lungs "we have bicarbonates giving up CO₂ and passing on in the blood as carbonates, in the stomach, HCl is excreted, and in the kidneys, acid phosphates are excreted by a reaction which leaves basic phosphates and carbonates." When the blood values for calcium and its anions are elevated, deposition of calcium salts might be expected to occur in instances in which there is a relative alkalinity, for there the solubility product is less. Crane (4) noted this type of deposit in the lungs. His case was one of metastases to the skeleton, the primary lesion being in the prostate. The suggestion was made that, due to the displacement of skeletal elements, there had occurred an excess content of the skeletal inorganic elements in the blood stream and, thereby, calcific deposits in the lung tissues. Such precipitations have also

¹ Published with permission of the Surgeon General United States Army, who bears no responsibility for the opinions expressed.

mation than you gave me, I am unable to give an opinion that would be worth the paper it is written upon. You know, Dr N , one must know all (or nearly all) about such cases before one can intelligently formulate ideas that are of any real value, and you do not want guesswork, even if I was disposed to guess.

"May I suggest that you write to your insurance carriers asking that I be informed regarding the status of your case, incidently stating that you know me and would like my opinion and advice. They will then send me a complete copy of the files in your case, and, after looking them over, I will give you or them an opinion and such advice as I deem wise in the circumstances. This is the usual procedure in matters of this sort. Has your case been set for trial? If so, when?"

"We have three Doctors by the name of P in Chicago. W J, a general practitioner, H L, an otolaryngologist, and L J, a neuropsychiatrist. I take it that it was L J to whom you refer. He is a man of the very highest standing, and one whose statements may be taken as almost the last word on any neuropsychiatric subject.

"I believe that arsenic neuritis is a definite and recognized clinical entity, and in your case may play an important part, if you can get it introduced into the evidence.

"Trusting that the foregoing will be helpful, and assuring you it will be my pleasure and desire to do anything I can toward aiding you in securing a favorable verdict, I am."

The defendant told me at a subsequent meeting of the Radiological Society that the case had been settled for a moderate sum, and disposed of in that way.

ANOTHER ECZEMA CASE²

The plaintiff in this suit was a farmer, in a north-central State, who had brought suit against his physician because of alleged malpractice in treating eczema on his hands.

The physician defendant carried no insurance against malpractice suits, so his State medical society fought the suit for him. I was asked, over long distance telephone, to assist in the case and was assured that I would be paid a moderate fee for my services.

The plaintiff was in Chicago and, while here, he made depositions which were to be used in the case. I was asked to attend conferences, consultations, assist the attorneys in the taking of the depositions, and make affidavits in regard to my opinion of the matter, etc.

The case was settled for much less than the plaintiff was suing for. I spent about two hundred dollars worth of time and billed that State society for \$50. The services were rendered in 1926 and the bill was paid in 1932. *But it was paid*

(To be continued)

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- (3) Am. Law Reg. Vol. 54 O. S. N. S. 45 p. 330, No. 6, June 1906.
- (4) Wigmore on Evidence Vol. 3 p. 2178 (Sec. 1692).
- (5) Foggett vs. Fisher 23 N. Y. App. Div. 207, Wharton on Evidence Sec. 686, Commonwealth vs. Wilson 1 Gray 337, Washburn vs. Cuddy, 8 Gray 430, People vs. Milard 53 Mich. R. 63, Epp vs. State 102 Md. R. 539, Harris vs. Panama R. R. Co. 3 Bosw. 7, Matter of Mason 60 Hun. 46.
- (6) Matter of Hock, 74 Misc. R. 15, 22, Foggett vs. Fischer 74 Misc. R. 5, Pahl vs. Troy City R. R. Co., 81 N. Y. App. Div. 308.

²Not so important but interesting—to me at least.



Fig 3 Lateral projection, localizing the calcifications to the hilum, and revealing a clear retrocardiac region

Hemoptysis usually occurs when the stone is released, or it may be noted repeatedly during the coughing attacks, and perhaps periodically, over stretches of weeks or months (16 and 19). Such cases are usually branded as active tuberculosis, regardless of repeated negative sputum studies. If secondary infections take place, the essential condition becomes masked by the symptomatology or signs of chronic bronchitis, bronchiectasis, abscesses or pneumonia.

No doubt many patients cough up small particles of calcareous debris without notice, or with the mere mention of a "grittiness" to their sputum. It is relatively rare that actual "stones" are expectorated. Though it is usually conceded that tuberculosis is likely the most frequent etiologic agent, even in that condition dislodgment of calcifications is of low incidence. Pritchard (13) noted only two such cases among 7 000 patients under his observation, while Stivelman (19) observed only one actual "stone-spitter" among 5,000 tuberculous patients.

Except in those cases of aspiration of foreign bodies, when one lith has been expectorated, more are likely to follow.



Fig 4 Photograph of stones collected by patient, expectorated by him during the past six years

There has been evidence to suggest that repeated sloughings of calcifications take place from the lung parenchyma, or the lymphatics, through the walls of the bronchial tree. It has been suggested that during this process there may occur a fragmentation of bronchial cartilage, and that with subsequent calcification of it, there is developed a nest of stones. Such a process probably accounts for the multiple productions in "chronic stone-spitters." Examples of such would include Lyter's patient (10), who spat up at least 40 stones over an interval of about six years, Elliott's case (5), from whom 56 concretions were collected within a period of two years, Lloyd's patient (9), credited with 50 stones, and the most spectacular case reported by Boerhaave (1), claiming the expectoration of over 400 calculi, before dying of "phthisis calculosa." Some of these stones have been very large, even to the size capable of almost complete obstruction of the larynx (16).

Though these pathologic conditions and clinical manifestations have been noted for many ages, and even though the symptomatology of stone asthma is relatively rare, it has seemed pertinent to speak again of the condition so that we may be reminded of broncholiths as a possibility in differential diagnosis, and so that procedures might be invoked to quickly alleviate a patient who might otherwise pursue a protracted, painful, and perhaps serious



Fig 1 Case 1 Postero anterior projection showing scattered areas of calcification which are most conspicuous at the right hilum



Fig 2 Right anterior oblique position, showing a 'nest of calcifications,' located in the region of the scarring was noted—bronchoscopically in the middle of the bronchus

been found in cases of excessive parathyroid hormone (7), as well as in hypervitaminosis D (17). More discrete calcific lesions, especially in cases in which interval studies reveal an increase in their dimensions, point to the possibility of osteoblastic metastases, *i.e.*, metastases of cells possessing osteoblastic properties. Histologically, these cells are derived from bone-forming tissues (3).

In general, then, when attempting to account for calcific lesions in the lungs, these four possibilities might be considered: (1) secondary calcification after degeneration or necrosis due to infection, (2) primary or secondary calcification of aspirated foreign bodies, (3) precipitation of the osseous inorganic elements, due to excessive concentrations of them in the blood, and (4) metastases of bone-forming cells. Concretions of grossly visible dimensions, produced by any of these four general types of processes, are spoken of as "pneumoliths," "lung calculi," or "lung stones." In the case of

aspirated liths, or when parenchymal concretions erode through the walls of the bronchi and become free in the lumen of the bronchi or bronchioles, the term "broncholiths" is applied. These become irritating to the mucosa. There results a persistent cough reflex, and with it, change in position of the lith, and further irritation. Excessive mucus is secreted—so much so, frequently, that the condition has been described as a "bronchorrhea" or "bronchocoele." Bronchial spasm is likewise characteristic. There develops, therefore, wheezing and expiratory dyspnea—the term, "stone asthma." Paroxysms of strenuous and painful cough are the result. At times, the severity of the cough is so great that patients speak of a "tearful sensation." These cutting pains are localized to the post-sternal region, or to one or the other lateral portion of the chest. Some of these attacks are climaxed by a powerful expulsive cough, with the production of a stone or of gritty material.



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or infarction. On the basis of broncholiths, infectious processes are seldom widespread, and febrile reactions might, therefore, be



Fig 6 Photo graph of stone expectorated by the patient. Compare its contour with that of the calcification visualized in the film above (Fig 5)

expected to be less severe than when the bacterial invasion has taken place by virtue of its own virulence. When hemoptysis supervenes, one is prone to brand the patient as actively tuberculous, even though repeated sputum analyses be negative and though other clinical evidence may be lacking. Broncholiths may account for extreme symptomatology in the active or quiescent tuberculous patient, and again the proper recognition of the process is important to establish prompt alleviation of the symptoms. If one were overly tumor-conscious at this stage, there might be an inclination to consider bleeding papillomas or even carcinoma of the tracheo-bronchial tract.

The following two cases are reported. The first exemplifies the most common type of broncholith formation, and the second, probably, the next most frequent basis.

Case 1 (Figs 1, 2, 3, and 4) W H N, a 54-year-old male, requested medical attention because of hoarseness and a "scratching" sensation in his throat. He stated that periodically, during the past six years, he had been bothered with attacks of a wheezing cough, at times accompanied with slight dyspnea, and associated with a slight amount of mucus and occasionally with blood. On four occasions he had raised definite stones, after the expulsion of each of these he expectorated a "moderate amount" of bright red blood. Otherwise, his sputum was occasionally blood-tinged and he frequently noted a grittiness as he expectorated. He felt very well between

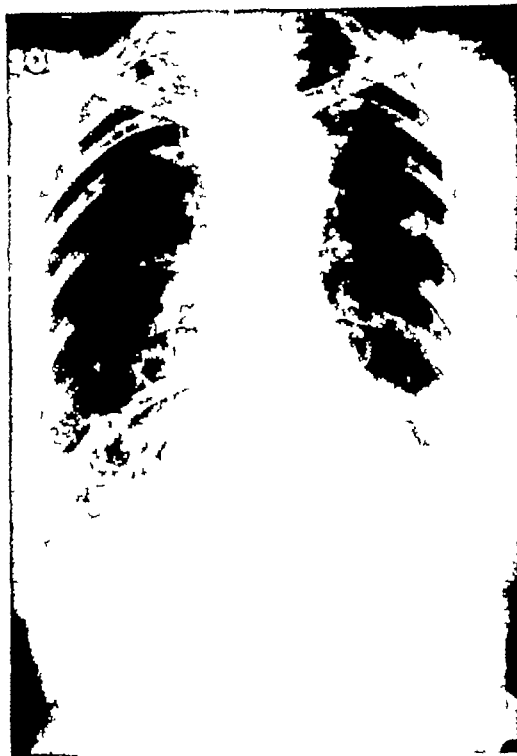


Fig 7 Postero anterior projection made some weeks after the expectoration of the stone. Note the clearing of the pneumonitis and the absence of the calcification previously visualized at its apex.

these attacks except for residual hoarseness, which seemed to develop after raising the stones. Some of the coughing spells persisted as long as three months.

The family history was virtually irrelevant, there was no record of tuberculosis nor of other lung conditions among the immediate or distant relatives. Remote past history was likewise of no assistance, the patient stated that he had been in very good health previous to the past six years, except for the usual diseases of childhood.

A physical examination revealed a healthy appearing individual of normal temperature, pulse, and respiration. The general examination was essentially negative except for the larynx, which appeared slightly edematous and pale and showed a content of mucoid material. Fluoroscopic examination of the thorax showed good motion of both domes of the diaphragm. The mediastinal structures did not change their position during either phase of respiration,

course of disability As previously mentioned, in the earlier stages of the process, bronchial spasm is usually a paramount forestall idle waste of time and effort to establish a specific protein or remedy a suspected myocarditis The deception of



Fig 5 Case 2 Postero anterior projection visualizing a wedge shaped pneumonitis in the right apex Note the contour of the calcification at the apex of this consolidation This film was made during the febrile period

manifestation Because of this, the case may too readily be relegated to the category of allergic or cardiac asthma Roentgenologic recognition of the concretion, perhaps with its peripheral wedge-shaped density of atelectasis or infiltration, would

diagnosis because of a marked bronchorrhea, or because of superimposed infection has already been mentioned Stone asthma should be considered, then, in cases which might be classified as bronchitis, bronchiectasis, pneumonia, abscess formations,

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Case 1 (Figs 1, 2, 3, and 4) W H N, a 54-year-old male, requested medical attention because of hoarseness and a "scratching" sensation in his throat. He stated that periodically, during the past six years, he had been bothered with attacks of a wheezing cough, at times accompanied with slight dyspnea, and associated with a slight amount of mucus and occasionally with blood. On four occasions he had raised definite stones, after the expulsion of each of these he expectorated a "moderate amount" of bright red blood. Otherwise, his sputum was occasionally blood-tinged and he frequently noted a grittiness as he expectorated. He felt very well between

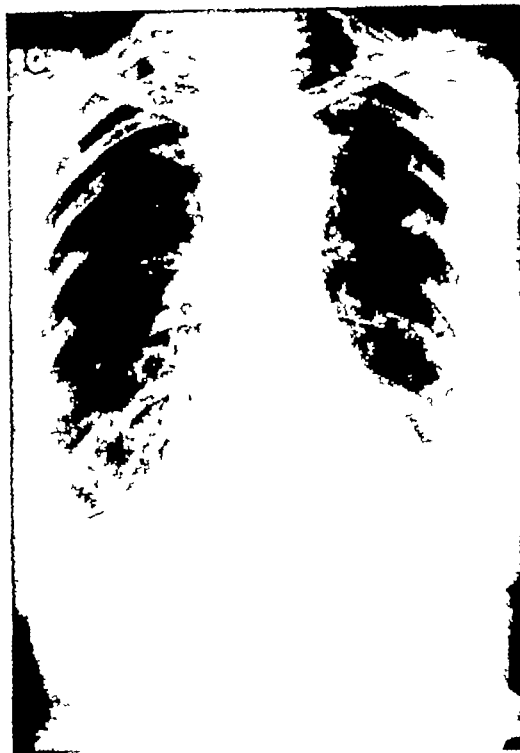


Fig 7 Postero anterior projection made some weeks after the expectoration of the stone. Note the clearing of the pneumonitis and the absence of the calcification previously visualized at its apex

these attacks except for residual hoarseness, which seemed to develop after raising the stones. Some of the coughing spells persisted as long as three months.

The family history was virtually irrelevant, there was no record of tuberculosis nor of other lung conditions among the immediate or distant relatives. Remote past history was likewise of no assistance, the patient stated that he had been in very good health previous to the past six years, except for the usual diseases of childhood.

A physical examination revealed a healthy appearing individual of normal temperature, pulse, and respiration. The general examination was essentially negative except for the larynx, which appeared slightly edematous and pale and showed a content of mucoid material. Fluoroscopic examination of the thorax showed good motion of both domes of the diaphragm. The mediastinal structures did not change their position during either phase of respiration,

and the swallowing function appeared normal. Roentgenography of the chest is represented herewith. The sputum was repeatedly negative for acid-fast organisms but showed many polymorphonuclears and epithelial cells.

Bronchoscopic examination by Dr. Gabriel Tucker showed "a slight thickening of the mucous membrane throughout the tracheo-bronchial tree. Very little abnormal secretion was present. At a point on the external and lateral wall of the right bronchus there was a break in the mucous membrane which was possibly the point through which the broncholith, that the patient coughed up, had been excreted."

Case 2 (Figs 5, 6, and 7). This patient was a woman of 60, who had had a tonsillectomy about nine weeks previous to the date of the first chest roentgenography (Fig 5). Her surgeon had noticed, during the course of the operation, the release of two tonsilliths and their falling into the pharynx. He was able to recover one of these but the other one disappeared. About two weeks after the operation this patient developed a "pneumonia" in the upper lobe on the right side. She maintained a febrile course, with drenching night sweats and a drastic cough, for more than three weeks. Because of the persistence of these symptoms, the roentgenologic study was made. A few days after the first roentgenography, she developed a very severe coughing spell which was climaxed by the expectoration of a lith, a photograph of which is shown in Figure 6. Her symptoms then promptly subsided. Subsequent roentgenography revealed a clearing of the wedge-shaped pneumonitis and the absence of a calcific density which had previously been visualized at the apex of that zone. The size and contour of the lith coincided with that of the calcific density.

SUMMARY

The subject of pneumoliths and broncholiths has been briefly reviewed. Emphasis has been placed upon the statement that the roentgenologist and clinician

should consider the possibility of bronchial liths when confronted with a case manifesting profuse bronchial secretions, bronchial spasm, intermittent hemoptysis, or, perhaps, evidence of localized pneumonitis. Differential considerations include, in particular, allergic asthma, cardiac asthma and tuberculosis, but also, chronic bronchitis, bronchiectasis, lung abscesses and pneumonia, and to a lesser degree, benign and malignant neoplasms of the tract.

We are indebted to Dr. Gabriel Tucker for the clinical record in the first case reported, and to Dr. J. H. Vastine for the loan of the second case reported.

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LEONTIASIS OSSEA A CLINICAL AND ROENTGENOLOGICAL ENTITY

REPORT OF A CASE

By J H GEMMELL, M D , *Philipsburg, Pa*

HISTORY

THE patient, M C , a male child of English extraction, aged seven and one-half years, was first referred to the orthopedic clinic of this hospital in June, 1931, with the complaint of a misshapen, enlarged head, curvature of the spine, and general debility. Roentgenograms of the skull and of the bones of the legs were taken, and at this time the family was notified that nothing from an orthopedic standpoint could be done for the child.

In October, 1934, when he was almost eleven years old, the child returned to the out-patient department for more complete study.

The boy was the fourth of seven living children of the mother, now 31 years of age. In addition to the seven children, she had had three other pregnancies, two resulting in miscarriages in early months, and the other resulting in the death of the child at birth, due to injury. All of the other living children are entirely free of physical defect. There is no antecedent history of any defect resembling that of this particular child. The mother had a normal labor in giving birth to the patient, and states that she believed his head to be a little large but that otherwise he seemed normal. He was breast-fed until the age of one year, sat up alone at seven or eight months, and began to walk at about one year.

There is a history of an attack of scarlet fever during the second year, with subsequent drainage from the ears for a long time, with a resultant hearing defect. Also, there was a severe attack of measles at four but with apparent complete recovery. At the age of six, the patient developed an infection in the right hand following an injury by a splinter of wood. This required considerable attention from a surgeon before healing finally took place, it is stated that

the boy has had practically no use of the right arm and forearm since. The mother says that she was not impressed with anything particularly unusual about the boy's head, except for size, until the seventh year, when it became noticeably more enlarged and of a peculiar shape, and began to hang over to the left side. The boy began school during that year but had to drop out due to failure to progress in his studies, and because of defective vision and his general physical condition. Since that time he has remained at home continually, and although able to be up and around, he is handicapped physically by the enormity of his head and the paresis of the right arm, and mentally by the defects in hearing and sight, and by inability to obtain any proper training. The child behaves well, is useful at home insofar as he is able, and his only complaint is of occasional headache. Gradual further enlargement of the head has been reported in the past three and one-half years, but there is little apparent change in the general appearance or contour of the skull and face since the examination in 1931.

PHYSICAL EXAMINATION

The child is generally underdeveloped and underweight for age eleven. He walks carefully, with a hunched-over posture and with the head tilted to the left, grossly, the striking features of the case are the size of the head, peculiar facies, thickened prominent clavicles, paresis of the right arm, forearm, and hand, and the marked dorso-lumbar scoliosis.

The head is symmetrically enlarged, particularly in the longitudinal axis, and is remarkable for its great weight, apparently out of all proportion to size, the impression in lifting the head is that of moving some solid metallic object. The fronto-



Fig 1

Fig 1 Note the shape of the head, the peculiar nasal contour, the slight proptosis, and the prominent lower jaw



Fig 2

Fig 2 The open mouth is a necessity for respiration

occipital diameter measures nine inches, the circumference in this plane is twenty-six inches

The facial features are eyes set wide apart, both being slightly exophthalmic, a peculiar nasal contour (similar to a saddle nose), the open mouth, and the prominent lower jaw. Inspection of the nose indicates almost complete obliteration of the nasal cavity, so that the boy is forced to keep his mouth open continually for satisfactory respiration. In the mouth, the hard palate is less arched than usual, the tonsils and adenoids are hypertrophied. The ears show no discharge, and there is no tenderness over the mastoids.

General examination of the neck, chest, and abdomen elicits no pathology of the thyroid, heart, or lungs, abdominal contents or genito-urinary system.

Neuro-psychiatric examination by Dr H E Eaton, of Warren, Pennsylvania—At the present time, the patient presents the picture of an emaciated young boy, barely able to sustain the weight of an enormous head. The right arm is atrophied, the patient being able to move it only slightly. The clavicles are thickened and prominent. There is a marked right dorsal left lumbar

scoliosis, with considerable reduction in size of the right chest. Examination of the cranial nerves reveals a marked bilateral nystagmus, though ocular movements are fairly well carried out and the pupils react to light and accommodation. The facial muscles are greatly stretched, though they all appear to be normally activated. He is partially deaf, and bone conduction is much better than air conduction. There is a marked fibrillary tremor of the platysma on the right, possibly due to the exertion required in keeping the head erect. There is considerable atrophy of the right arm and the muscles of the shoulder girdle on the right, and the left shoulder is easily dislocated but returns quickly to its socket with slight manipulation. There is marked diminution of muscle power in the right arm, forearm, and hand, the patient using his left arm to place his right arm and hand where he wishes them. Tendon reflexes are present on both sides but are more active on the left. In addition to the above findings, there is also a very marked myopia.

Psychometric examination gives this boy a mental age of five years, ten months, with an IQ of fifty-three. However, this examination does not entirely reveal the

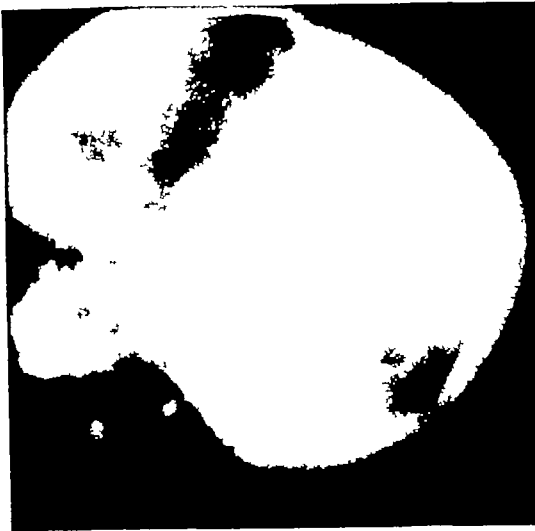


Fig 3

Fig 3 Roentgenogram taken in June, 1931. All the bones of the skull and face are involved in a sclerosing process, obliterating the nasal sinuses and the mastoids.



Fig 4

Fig 4 Roentgenogram taken in October, 1934. Increased thickness of bones is particularly noticeable in the frontal region and base of the skull. This increase is mostly at the expense of cranial capacity.

child's mental capacity because of his deafness and difficulty in seeing well. He has had little schooling because of his infirmity. However, he appears fairly alert, and talked freely with the examiner, though he was at first fearful that he should be hurt, but, when reassured on this point, cooperated to the best of his ability with all examinations. He appears to recognize his physical difficulty and asked the examiner if he could do something to help him.

In the examiner's opinion, this boy's neurologic findings are probably secondary to the involvement of the bone. The nystagmus can be explained on the basis of involvement of the labyrinth, although better bone conduction than air conduction indicates middle ear involvement, possibly by the same disease. The involvement of the shoulder girdle and arm muscles on the right side is possibly due to injury to the brachial plexus or to nerve roots, and decreased tactile sensibility on the right appears to bear this out.

LABORATORY EXAMINATION

Blood cytology showed red blood cells 1,200,000, white blood cells, 6,900 per cubic mm, with a hemoglobin of 80 per

cent, and with a differential count of neutrophils, 45 per cent, lymphocytes, 50 per cent, and eosinophiles, 5 per cent.

Blood chemistry showed sugar, 113 mg, non-protein nitrogen, 36 mg, phosphorus, 5.2 mg, calcium, 10 mg per 100 c.c. whole blood.

The blood Wassermann was negative.

Urine and spinal fluid examinations were negative. Basal metabolism, 1 per cent. A biopsy was not obtainable.

ROENTGEN EXAMINATION

In 1931, when only the head was examined, all the bones of the skull and face showed excessive symmetrical overgrowth, resulting not only in general enlargement out of proportion to age, but also in extreme thickening. This overgrowth was of a very dense consistency throughout, there being no cystic areas present anywhere. The mandible was thickened and sclerotic. The paranasal sinuses were completely obliterated, as were the mastoids, and the petrous portions of the temporal bones and the entire base of the skull were greatly sclerosed. The sella turcica could scarcely be discerned, apparently due to the piling up of bone in the basal structures and side



Fig 5

Fig 5 Roentgenogram taken in October, 1934. The disease process appears symmetrical.



Fig 6

Fig 6 The clavicles are thickened and sclerosed in a fusiform manner, and the ribs are so widened that a diagnosis of lung pathology would be impossible.

walls of the skull in that plane, the sella appeared somewhat shallow and measured 14 millimeters, inside greatest diameter, on the original roentgenogram (Fig 3).

The examination in October, 1934, was more complete. Contrary to the impression of the mother, the over-all dimensions of the skull showed no increase. However, the progression of the bony overgrowth inwardly was notable. By way of demonstrating this, measurement of the thickness of the frontal bone on the 1934 film (Fig 4) was 3.5 cm, in comparison to 2.5 cm on the 1931 film for the same portion of bone, the same focal distance having been used in each case. Thus it would seem that the cranial capacity is diminishing. All the other bones of the skull and face showed proportionate increases in thickness. The sella was less easily seen, and measured only 10 mm inside diameter. The technic required to obtain the original roentgenogram, reproduced as Figure 4, was 6 sec-

onds, 15 ma, 80 kv p, 30-inch focal film distance, Bucky diaphragm, using standard film in a cassette, with parspeed intensifying screens.

Other portions of the skeleton were involved in this sclerotic process, particularly the ribs and clavicles. The latter were enlarged in a fusiform manner, while the former were more diffusely thickened to such an extent that the rib interspaces were greatly narrowed. There was apparent a beginning sclerosis of the cervical vertebrae, but the dorsal and lumbar regions of the spine were of normal density. Of particular interest was the lack of significant change in the scapula, pelvis, or bones of the extremities, other than the decalcification from disuse of the right upper extremity bones.

There were no cystic areas in any portion of the skeleton, and it is of note that in the skull there was not the "curled, kinky-hair" appearance characteristic of Paget's disease.



Fig 7

Fig 7 Showing the dorso lumbar curvature The ribs are almost as dense as the vertebrae The pelvis is normal



Fig 8

Fig 8 The bones of the thighs and legs are normal

DISCUSSION

Virchow (9) first used the term "leontiasis ossea" in describing the facial and cranial deformities due to hypertrophy of the bones of the face and skull. Although acromegaly and other benign and malignant lesions resulting in facial disfigurement have since been discussed as leontiasis ossea, this terminology has been lately confined to cases in which hyperostosis is the predominant lesion. Knaggs (5) classified a large number of these cases into a creeping periostic variety and a diffuse osteitic variety. The histology of the disease is usually that of osteitis fibrosa, i.e. disappearance of normal bone and replace-

ment at first with fibrous tissue which later ossifies.

In addition to what might be termed pure forms of the disease, are cases in which manifestations of Paget's osteitis deformans or occasionally perhaps von Recklinghausen's osteitis fibrosa cystica are present, as well as the hyperostosis of the cranial and facial bones ascribed to leontiasis. Indeed, Freedman (3) suggests that leontiasis ossea can be considered a localized form of either of these diseases since the histologic findings in all are similar.

However, it must not be overlooked that typical cases of Paget's disease or von Recklinghausen's disease do not possess the

profound hyperostoses of the skull and particularly of the facial bones characteristic of leontiasis. Harvey Smith (8) describes typical Paget's disease of the skull as "undue prominence of the frontal bones, and non-involvement of the face. The bone is several times normal in thickness, without encroaching upon the skull cavity. There is a finely porous outer table covered with small nodules of bone." The classical picture of von Recklinghausen's disease, when it involves the skull, is that of general bone decalcification, many cystic areas, and an irregular mottled sclerosing process. The facial bones are not involved. It might be mentioned too that these diseases differ from each other considerably not only from roentgenologic and clinical standpoints, but also from the etiologic standpoint, in that osteitis fibrosa cystica is a disease associated with parathyroid dysfunction, and is frequently characterized by typical blood calcium and phosphorus changes, while Paget's disease is not thus established. In a recent editorial, Doub (2) discussed the etiology of von Recklinghausen's disease. And, on the other hand, it may be repeated that so-called pure forms of leontiasis ossea may be manifested entirely as proliferative sclerosing bony processes involving principally the face and skull, and show no distinctive resemblance roentgenologically or clinically to these other diseases.

Following are mentioned a few case reports recorded in recent literature which illustrate some of the points under discussion. Hamburger and Nachlas (4) describe a case of a woman 56 years of age, with hyperostotic deposits obliterating the maxillary sinuses and involving the facial bones generally, and also with apparent Paget's disease of the cranial vault and of the tibiae. Ivemy's (6) unusual case is that of a boy eleven years of age, with an asymmetrical leontiasis affecting mainly the right side of the face, and with other profound changes in the skull and throughout the skeleton, in some areas, the bony change is reported as resembling Paget's disease, and in others, as von Reckling-

hausen's disease. Freedman (3) also cites a case of asymmetrical hyperostosis of the right side of the face with a resemblance to Paget's disease in the other portion of the skull. Capon (1) describes his case as the diffuse osteitic form, the hyperostosis affecting the upper maxilla, the frontal bone, and the anterior portion of the base of the skull, chiefly on the left side. Hyperostosis is the predominant feature in this case. The impression gathered upon reviewing these cases is that we are dealing with a definite clinical and roentgenologic picture, leontiasis ossea, to which there may or may not be added evidence of other bone dyscrasia—usually a typical Paget's disease. And it would also seem that the signs of leontiasis appeared first.

Reference need not be made to typical cases of Paget's disease. LeWald (7), in discussing Freedman's paper, mentioned a study of 69 cases in which not a single one showed the involvement of the facial bones peculiar to leontiasis.

In the present case, and in the cases just referred to in which blood serum calcium determinations were made, the reported lack of significant increase of this constituent in the blood indicates in a general way a differentiation from the majority of cases of osteitis fibrosa cystica.

The etiology of leontiasis ossea is not definitely known, but trauma, syphilis, non-specific infection, and endocrine pathology each has been suggested as a causative factor. It is impossible to determine in this case whether or not the disease was present at birth, it might possibly have originated as a result of the persistent otitis media which existed during the second year. There is no history of trauma to the head, and evidence of syphilis and endocrine disturbance is lacking.

SUMMARY

Granted, that there is a pathologic resemblance of leontiasis ossea to Paget's osteitis deformans and to von Recklinghausen's osteitis fibrosa cystica, yet

(1) Cases of leontiasis occur having none of the usual clinical or roentgenologic fea-

tures of either Paget's or von Recklinghausen's disease

(2) There are cases of leontiasis having associated bone lesions suggestive of these other diseases in atypical forms

(3) Innumerable cases of Paget's disease exist without any evidence of leontiasis

(4) Many cases of von Recklinghausen's disease occur without leontiasis, they are related to parathyroid dysfunction, and usually show variation from the normal values for calcium and phosphorus in the blood

(5) There is apparently something fundamentally different and distinct in cases having this diffuse hyperostosis of the skull and facial bones, regardless of the added presence or absence of bone lesions suggesting other disease

CONCLUSION

It is contended that leontiasis ossea may

still be classified as a clinical and roentgenologic entity

The present case is offered as a pure form of the disease

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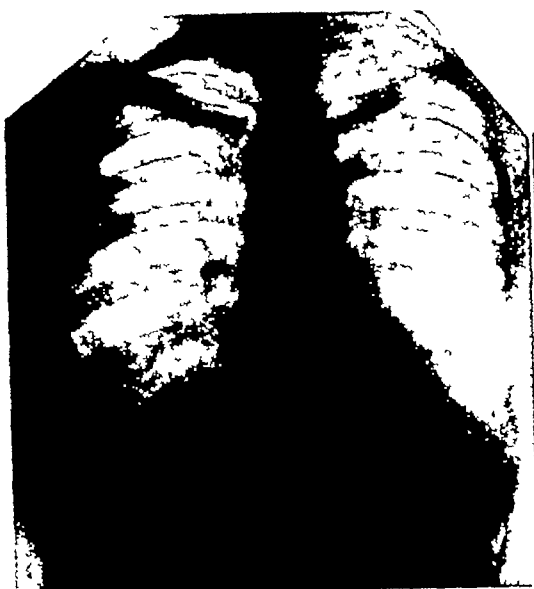


Fig 1 Case 1 Roentgenogram showing infraclavicular cavity on left

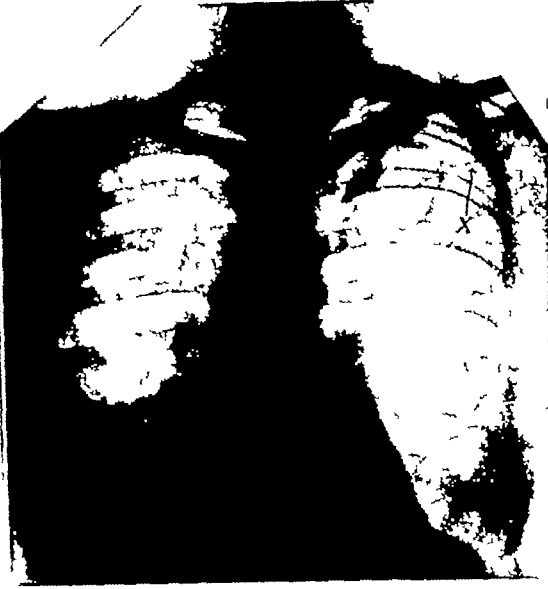


Fig 2 Case 1 Ineffective pneumothorax, cavity larger than before

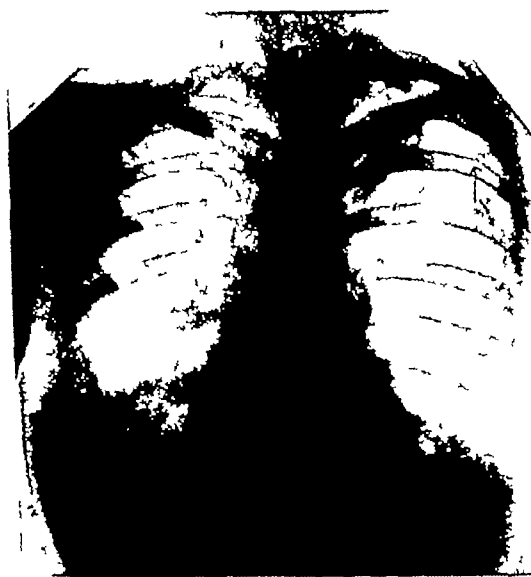


Fig 3 Case 1 Two weeks after partial pneumolysis Lateral adhesion (λ) was not severed, cavity is diminished in size

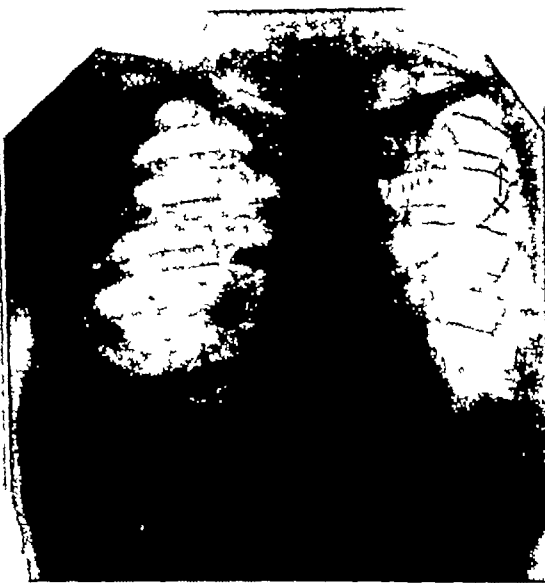


Fig 4 Case 1 Cavity closed in spite of lateral adhesion (λ) not having been severed

it is amazing how often one finds that there are many more adhesions, often of quite a different character, than were observed roentgenologically. For instance, as Matson has pointed out, the floor of an uncollapsed cavity looks sometimes exactly like a pleural adhesion. The thoracoscopist, relying upon such an erroneous

diagnosis, would cause an irreparable damage to the patient.

It will often be impossible to answer the important question, "Which of several adhesions is chiefly responsible for the failure of the cavity to collapse?" It is a well-known fact that the closure of such cavities, after only partial pneumolysis,

THE RÔLE OF THE ROENTGENOLOGIST IN THE PROPER MANAGEMENT OF PLEURAL ADHESIONS PREVENTING EFFECTIVE PNEUMOTHORAX COLLAPSE

By FELIX BAUM, M D , *Newark, N J*

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THE continuance of an ineffective artificial pneumothorax attempted over a long period of time is useless. The dangers of extension of the tuberculous process from the open cavity into the affected lung, as well as cross-firing into the so-called good lung, are great. Hemorrhages cannot be prevented, and spontaneous pneumothorax and subsequent empyema are especially menacing in cavities localized just below the surface of the lung which are held open by adhesions. The high-pressure pneumothorax, with and without artificial fixation of the mediastinum, is sometimes successful in such cases if administered with small doses of air given at short intervals, but its possible dangers cannot be underestimated. A tear near the thoracic wall, followed by uncontrollable hemorrhages into the pleural sac, or a tear into the lung tissue, followed by spontaneous pneumothorax, cannot be prevented, even if the best technical skill is assured.

Therefore, electrosurgical severance of pleural adhesions should be much more often practised than heretofore, in order to convert an ineffective artificial pneumothorax into an effective one. The open method by thoracotomy is dangerous. The percentage of pleural empyemas in such cases is high, and the shock to the weakened tuberculous individual is, in many instances, too severe to justify such a procedure. Since thoracoscopy is relatively harmless, intrapleural closed pneumolysis should be the treatment of choice in such instances.

WHAT ARE THE ROENTGENOLOGIC INDICATIONS FOR THIS TYPE OF OPERATION? OF WHAT AID COULD THE ROENTGENOLOGIST BE TO THE THORACOSCOPIST?

Every experienced phthisiologist knows that pleural adhesions are present in almost

every case of artificial pneumothorax. They are almost physiologic, and disappear or give way in many instances even under negative intrapleural pressure. But the picture changes as soon as the adhesions become organized, forming fibrous strings, cords, bands, or fans, which prevent the tuberculous cavity from collapsing, or which, by contraction, cause a re-expansion of the collapsed lung and re-opening of the cavity already closed by an effective collapse. Here, the aid of the roentgenologist is invaluable. It is up to him to study carefully large series of chest films taken at short intervals, and to describe every single adhesion and its character, often resorting to lateral films taken at different angles, in order to differentiate between cords and fans. These latter frequently prove to be unsuitable for closed intrapleural pneumolysis on account of the danger of lung tissue or cavities extending into the adhesions. He will often be able to call the phthisiologist's attention to the fact that, in his attempt to stretch pleural adhesions, he had accomplished nothing but a mediastinal hernia with its consequences, such as disturbance in the lesser circulation, downward pressure of the diaphragm, etc. He will try to determine fluoroscopically, if possible, the character and amount of fluid in the pleural sac, and advise aspiration if it interferes, in his opinion, with the proper visualization of the adhesions in case of pneumolysis. He will study the contralateral lung with greater care, and advise for or against pneumolysis, depending upon the extent and severity of the contralateral tuberculous process. And, finally, he will be careful in committing himself as to the character and number of pleural adhesions, leaving the decision in questionable cases rather to the thoracoscopist. Thoracoscopically,

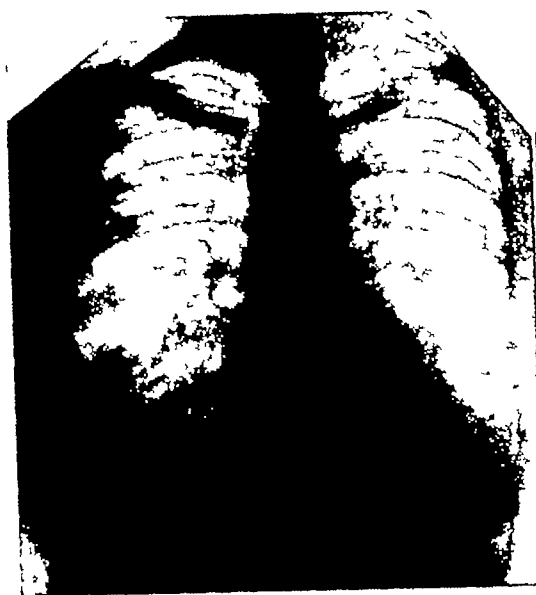


Fig 1 Case 1 Roentgenogram showing infra-clavicular cavity on left



Fig 2 Case 1 Ineffective pneumothorax, cavity larger than before

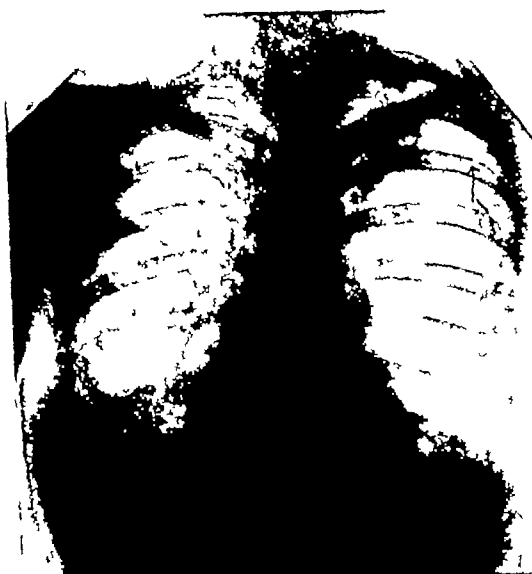


Fig 3 Case 1 Two weeks after partial pneumolysis Lateral adhesion (A) was not severed cavity is diminished in size

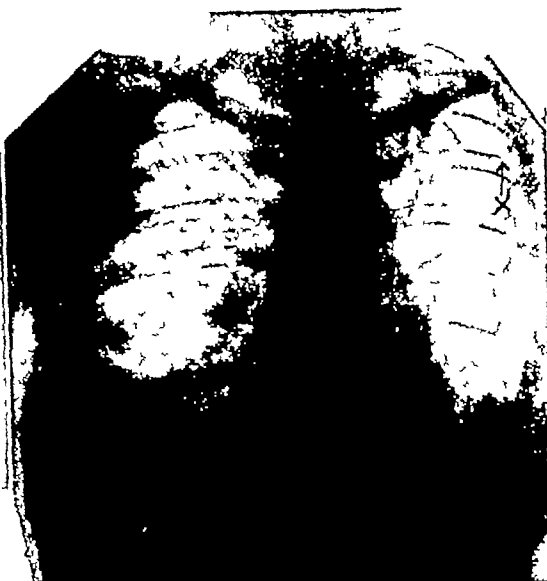


Fig 4 Case 1 Cavity closed in spite of lateral adhesion (A) not having been severed

it is amazing how often one finds that there are many more adhesions often of quite a different character, than were observed roentgenologically. For instance, as Matson has pointed out, the floor of an uncollapsed cavity looks sometimes exactly like a pleural adhesion. The thoracoscopist, relying upon such an erroneous

diagnosis, would cause an irreparable damage to the patient.

It will often be impossible to answer the important question, "Which of several adhesions is chiefly responsible for the failure of the cavity to collapse?" It is a well-known fact that the closure of such cavities, after only partial pneumolysis,



Fig 5 Case 2 Ineffective pneumothorax, apical and lateral adhesions

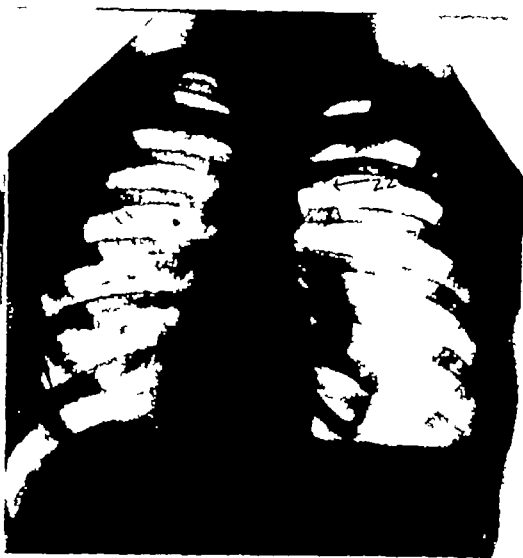


Fig 6 Case 2 Lateral adhesion severed, apical adhesion untouched, and cavity closed

is not rare if the adhesions are apical, string- or cord-like, and left intact, because they are easily stretched. Also, in exceptional cases, the thoracoscopist can accomplish a favorable result if he omits severance of adhesions which, judging from the x-ray appearance, he should have cauterized in order to guarantee the obliteration of the cavity. The following is an example.

A widow, 35 years of age, mother of two children, with a positive sputum and a large infraclavicular cavity on the left (Fig 1), was given high-pressure pneumothorax without success (Fig 2). The cavity, after pneumothorax treatment, seemed to be even larger than before. The patient was sent to me from a sanatorium, with the request that I sever the pleural adhesions electrosurgically. I was asked to pay special attention to one thick lateral adhesion (λ). This, from the x-ray appearance, seemed to be mainly responsible for the failure of the cavity to collapse. Thoracoscopically, I found eight adhesions, seven apical ones posteriorly, and one broad lateral band (λ). It was relatively easy, by the two-puncture method, to sever the seven apical strings and cords, but the lateral broad band (λ) showed, on

close transillumination, a definite pulsation which was not transmitted from the heart but was due to a distinctly visible vessel within. I decided, therefore, because of the danger of an intrapleural hemorrhage, to leave it alone. The patient was discharged from the hospital after a week, and the physician at the sanatorium was advised to continue artificial pneumothorax with small doses of air to be given at short intervals. The next roentgenogram (Fig 3), taken two weeks later, showed, much to my surprise, the cavity greatly diminished in size, and the film taken four weeks after pneumolysis revealed a complete closure of the cavity (Fig 4). The sputum became negative immediately and has remained so since. The patient is now doing housework and receives ambulant pneumothorax treatment from her family physician.

The simple relaxation of the cavity, by cauterization of the minor apical adhesions alone, was sufficient to obtain an effective pneumothorax in spite of a broad lateral band left untouched.

In contrast to this case I call attention to two films of another patient (Figs 5 and 6), one taken before and one after closed intrapleural pneumolysis. In this case the

severance of the lateral band (Z) alone was sufficient to secure an ideal collapse of the cavity without touching the apical adhesion (ZZ)

SUMMARY

The roentgenologist's aid is of great value in cases of incomplete collapse of tuberculous cavities held open by pleural adhesions. In questionable cases, the roentgenologist should not commit himself, because the roentgenogram differs frequently from the thoracoscopic picture.

A case is presented in which a lateral broad adhesion of a vascular character,

which, from the roentgen standpoint, appeared to be alone responsible for the failure to close a cavity, was left untouched without being severed. After cauterization of minor, apparently unimportant apical adhesions, this band stretched sufficiently to permit a complete closure of the cavity. Films of a contrast case are presented.

The final decision as to the procedure of intrapleural closed surgery should not be made on roentgenologic evidence alone, but also by thoracoscopy.

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A HISTOLOGIC STUDY OF THE EFFECTS OF X-RAYS ON FROG SKIN

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IN 1903, Allen (1) recorded that, following x-radiation, the skin of a man showed an increase of connective tissue in the corium. The epidermis had disappeared in some places but in other sections it sent processes downward into the corium. Necrosis of tissue was observed under the epidermis. In another of his experiments, the skin of a frog was irradiated for 57 minutes and immediately fixed in Zenker's solution. An increased vascularity was noted. The following year Una (8) reported that irradiation caused a thickened epidermis which gradually thinned. Collagenous material increased in thickness and the intima of capillaries were closed by thickened walls. Telangiectases were observed. The squamous cells sloughed off and all epidermal appendages atrophied. This article gives a good review of the meager literature until 1906.

Porter and White (7) reported that x-radiation produced growths of finger-like projections into the corium, along with dilated vessels, swollen cells, and a disappearing epidermis. The corium contained dilated subpapillary vessels filled with blood. The walls of the enlarged vessels were thicker. In some x-rayed specimens, it was difficult to determine where the corium stopped and the epidermis began. Lack of pigmentation was associated with early x-ray burns. It was hypothesized that the first reaction was on the vascular supply, which caused a thrombosis of the vessels. This was followed by an ulceration, and after four days it was observed that leukocytes had filled the vessels, but, after thirty days had elapsed, the walls of the old vessels had thickened and new capillaries were observed.

Wolbach (9) found that dilated capillaries and telangiectases in a rarified corium were quite common results of irradiation of

human skin. Various stages of dilation were observed in the capillaries, and some were even obliterated by proliferation of the endothelium. Elastic and collagenous fibers were increased, the walls of the vessels were thickened, and although the epidermis seemed to be thickened the horny layer was lacking. The downgrowths were very pronounced and the tissue immediately below the epidermis became loose-textured, showing imperfect repair and lesions of the vascular system. The deeper connective tissue became much denser and many large cells were noticeable. Wolbach found that tumors appeared on human subjects several years after irradiation and after the establishment of severe chronic changes of the skin characterized by great thickening of the tissue, hyperkeratosis, and the loss of the epidermal appendages. Downward growths from the epidermis preserved its continuity by obtaining nourishment from deeper connective tissue. The obliteration of the capillaries was probably due to the swelling of the corium. Ulcerations were present only in places where the degenerated area was too large to be bridged by the epidermis. The downgrowths show the typical properties and cells of the epidermoid carcinoma. It is thought that the carcinoma cell is one isolated from the rest of the body through gradual withdrawal of nutrition owing to successive obliteration of vessels, and that the cells thus gradually acquired a greater capacity for securing nutrition and finally became capable of living at the expense of other cells. These experiments confirmed the results gained by previous workers whose articles are briefly summarized in this article.

Del Buono (2) concluded that the first reaction of irradiation was on the vascular system, causing dilation of the minute ves-

LIGHT EFFECTS OF X-RAYS ON FROG SKIN



Fig 1 Normal frog skin ($\times 250$)



Fig 2 Five days after three erythema doses ($\times 250$)



Fig 3 Twelve days after three erythema doses ($\times 250$)



Fig 4 Twenty-two days after three erythema doses ($\times 250$)

sels soon after exposure. The younger cells were injured so that their repair took a long time. The result depended on the state or condition of the patient, the young being more sensitive. Latent burns were sometimes noticed although earlier signs were absent. Ewing (3) also observed that growing cells were the most sensitive, while the squamous cells were least so. Swelling of the tissue cells was probably due to the nuclear cytoplasm imbibing water. Mitosis was reduced with abnormal forms appearing. Lymphocytes and plasma cells were increased in the irradiated areas. Heavy irradiation caused mucinous degeneration of collagen fibrils, fragmentation of muscle fibers, hemorrhage of capillaries, and then the actual growth of fibroblasts with the development of new capillaries. The membranes around fat particles were ruptured, allowing the contents to escape.

Conflicting evidence was added when there was found to be no increase in the elastic fibers of mouse skin following irradiation. Also, irradiated carrots proved toxic to guinea pigs, and a theory was propounded that the results obtained in the skin were due to an avitaminosis and not to a direct attack on the cells.

During 1929, Pohle (5) produced histologic evidence that irradiation caused reserve capillaries to open. These vessels remained enlarged as their walls thickened. Later, Jacobson and Waddell (4) x-rayed rats and studied the skin tissue. The horny layer was observed to come off from the epidermis, and the latter to become loosened from the corium. The collagenous fibers of the corium became swollen and fused. Leukocytes digested the area killed, leaving an open vacuole. Intercellular bridges disappeared. Pohle and Bunting (6) have confirmed these results. Excellent plates which show the effects of irradiation on the skin are presented in the last two experiments mentioned.

EXPERIMENTAL PROCEDURE

The following report gives an account of the action of the rays on frog skin and a theory accounting for this action. Frogs

were used because the average sections of skin are much more uniform than those from human subjects, and because these animals are easier to control.

Three female frogs were tied on their backs and their white undersides irradiated with an unfiltered beam from an x-ray tube (W target) with a potential of 100 kv and a current of 5 milliamperes. The focal distance was 8 inches. The machine had double disc mechanical rectification. Frog *A* was kept as a control, *B* was irradiated for 3 minutes, 36 seconds, comparable to three human erythema doses, *C* for 6 minutes or five erythema doses, and *D* for 7 minutes, 24 seconds, or seven erythema doses. Millimeter-square sections of skin were cut from the irradiated parts at various time intervals and fixed in Zenker's solution. Histologic slides were made and stained with hematoxylin-eosin dyes.

The normal skin consists of the epidermis, which has squamous, cuboidal, and columnar cells, and the corium, which first shows the stratum spongiosum, a loose layer containing glands, blood vessels, pigment cells, and then the stratum compactum, a dense layer of connective tissue (Fig 1).

Fused muscular fibers were noticed in the skin of frog *B* five days after irradiation. The corium was loosened from the epidermis and became quite wavy. It appeared that the proteins had become coagulated (Fig 2). Twelve days after irradiation the skin of the same frog showed marked degeneration in the stratum spongiosum, and the vessel walls became enlarged. The columnar cells were becoming less prominent and the outer cells of the epidermis were dying (Fig 3).

Regeneration of the skin tissue of *B* became rather noticeable 22 days after irradiation, for the epidermis appeared to be thickening and sending processes into the corium. However, the stratum spongiosum was definitely degenerated and the outer cells of the epidermis seemed to be swelling (Fig 4). Degeneration of the epidermis could not be doubted after 61 days. It was much thinner and no columnar cells



Fig 5 Sixty one days after three erythema doses
($\times 250$)



Fig 6 Twelve days after five erythema doses
($\times 400$)



Fig 7 Sixty eight days after five erythema doses
($\times 200$)



Fig 8 Twenty two days after seven erythema doses
($\times 750$)

could be found, and, contrary to previous observations, the intercellular bridges were more defined between the larger cells that remained. Vascularization became more pronounced between the corium and the epidermis. The lower part of the corium was much heavier and many new cells could be found about the minute vessels. The walls of the vessels were definitely thicker and the vascular system was increased. Pigmentation was also more pronounced (Fig 5).

The skin of frog C, which had received five erythema doses twelve days before, gave definite signs that the corium was tearing away from the epidermis, leaving degenerated cells between. The squamous cells were sloughing off and the columnar cells were becoming granular in nature (Fig 6). After sixty-eight days, all of the columnar cells had disappeared and the epidermis had decreased in thickness. The upper layer of the corium exhibited an intensely proliferated area of growth, having many cell nuclei as previously described. The entire corium had thickened as before and the increased vascularization was also present (Fig 7). Under high magnification the epidermal cuboidal cells appeared to be fused together, although those that were more normal had very pronounced intercellular bridges. Some mitotic figures were visible.

Frog D died twenty-two days after seven erythema doses had been applied. At this time all columnar cells had disappeared and the intercellular bridges were intensified. There seemed to be no regeneration at this time as there was in the case of B. Vascularity had increased and the corium had thickened. The granulations in the cell nucleus appeared to be moving to the outer portions of the nuclei (Fig 8). These observations in general confirm the results of previous investigators, and demonstrate that different dosages will give different effects. The hardness of the individual cell enters into the reaction, as has been shown by γ -radiation of different bacteria,

and by determining their death rate under different dosages.

CONCLUSION

The present investigator believes that the effects described are due directly to the action of the γ -rays on the cells or to the action of the secondary cathode rays produced by the primary beam impinging on the tissue. According to the most modern viewpoint, "H" substance (10) is liberated quite slowly from the injured cells during a long period of time, causing the capillaries to dilate. Because of this gradual seepage of "H" substance, the dilation persists, and the power of contracting to the original state is lost as other cells grow and fill the stretched network forming the walls of the vessels. This action undoubtedly thickens the walls and makes them less permeable to the nutritive elements that are necessary for the growth of the tissue cells. Gradually some die while others acquire abnormal forms of growth. X-ray shock and increased nitrogen in the urine soon after irradiation might also be explained by the sudden release of "H" substance in more sensitive tissue.

536 W 114th St

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THE EFFECTS OF X-RAYS ON THE DEVELOPING CHICK

By J M ESSENBERG, PH D, *Chicago*

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INTRODUCTION

DURING the course of the investigation of the effects of roentgen rays on the origin and development of the gonads in the chick, certain developmental anomalies and malformations have appeared in the material studied. It became apparent that such irradiation had affected the vitality and hatchability of the eggs, and that further study was indicated. The results of these observations constitute the material of this paper.

APPARATUS

The x-ray machine¹ used was mechanically rectified and provided with a Landauer roentgenometer. A Universal Coolidge therapy tube was used. The set-up of the machine for the entire experiment was as follows. The kilovolt meter was set at 96, which delivered 112 peak kilovolts as measured by the sphere gap, the milliammeter was set at 6 milliamperes, the focal distance was 10 inches, the filter was equivalent to 4 mm aluminum, the roentgenometer was kept at 3.2 microamperes, which, by calculation, gave 0.6 r per second. The desired r, or dosage, was obtained by varying the time of exposure.

A specially designed irradiation box was used for this experiment. In it was incorporated a portable incubator, a candler, and a scattered-ray absorber.

An electrically heated incubator was used for this work. It was provided with a reliable thermostat, humidity equipment, and a means of ventilation. The temperature was kept at 103° F, with a variation less than 0.2° F, the humidity being kept at 50 to 60 per cent. The eggs were turned twice in 24 hours.

MATERIAL AND METHODS

Eggs of white and brown Leghorn chick-

¹ Type C model, made by the Standard X-ray Company.

ens were used for this experiment. All were incubated for a certain period of time before they were irradiated. The age of the embryo varied from 19 to 243 hours incubation. The vitality of all eggs was established with the aid of the candler before irradiation. Controls were kept for each experiment. With the exception of irradiation, the control eggs were subjected to identically the same treatment as were the experimental eggs.

In the early part of the experiment it seemed necessary to determine the effect of the shell and shell membranes on the x-rays. Out of the total of 572 eggs, 63 were irradiated through a window cut in the shell and its membranes. After irradiation, the opening was sealed and the eggs incubated. The rest of the eggs were x-rayed with their shells intact. Another attempt was made by measuring the rays of known amount with a Victoreen r-meter after they had passed through the shell and the shell membranes. The results will be discussed later in the paper.

RESULTS

The results of this experiment can be divided into the following groups: (1) Embryos that died in the shell at or shortly after irradiation, (2) chicks that died after considerable development, which are hereafter spoken of as 15± days old chicks, (3) chicks that died in the shell at the completion of development, or full term, (4) chicks that hatched, (5) chicks that showed various degrees of anomalies and deformities.

EMBRYOS THAT DIED IN THE SHELL AT OR SHORTLY AFTER IRRADIATION

These constitute a large group, 255 out of a total of 572 eggs. All were incubated prior to radiation. The age varied from 19 to 240 hours. The dosage used was from 60 to 600 r. All were known to be in the

could be found, and, contrary to previous observations, the intercellular bridges were more defined between the larger cells that remained. Vascularization became more pronounced between the corium and the epidermis. The lower part of the corium was much heavier and many new cells could be found about the minute vessels. The walls of the vessels were definitely thicker and the vascular system was increased. Pigmentation was also more pronounced (Fig 5).

The skin of frog *C*, which had received five erythema doses twelve days before, gave definite signs that the corium was tearing away from the epidermis, leaving degenerated cells between. The squamous cells were sloughing off and the columnar cells were becoming granular in nature (Fig 6). After sixty-eight days, all of the columnar cells had disappeared and the epidermis had decreased in thickness. The upper layer of the corium exhibited an intensely proliferated area of growth, having many cell nuclei as previously described. The entire corium had thickened as before and the increased vascularization was also present (Fig 7). Under high magnification the epidermal cuboidal cells appeared to be fused together, although those that were more normal had very pronounced intercellular bridges. Some mitotic figures were visible.

Frog *D* died twenty-two days after seven erythema doses had been applied. At this time all columnar cells had disappeared and the intercellular bridges were intensified. There seemed to be no regeneration at this time as there was in the case of *B*. Vascularity had increased and the corium had thickened. The granulations in the cell nucleus appeared to be moving to the outer portions of the nuclei (Fig 8). These observations in general confirm the results of previous investigators, and demonstrate that different dosages will give different effects. The hardness of the individual cell enters into the reaction, as has been shown by γ -radiation of different bacteria,

and by determining their death rate under different dosages.

CONCLUSION

The present investigator believes that the effects described are due directly to the action of the γ -rays on the cells or to the action of the secondary cathode rays produced by the primary beam impinging on the tissue. According to the most modern viewpoint, "H" substance (10) is liberated quite slowly from the injured cells during a long period of time, causing the capillaries to dilate. Because of this gradual seepage of "H" substance, the dilation persists, and the power of contracting to the original state is lost as other cells grow and fill the stretched network forming the walls of the vessels. This action undoubtedly thickens the walls and makes them less permeable to the nutritive elements that are necessary for the growth of the tissue cells. Gradually some die while others acquire abnormal forms of growth. X-ray shock and increased nitrogen in the urine soon after irradiation might also be explained by the sudden release of "H" substance in more sensitive tissue.

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to extricate themselves from it. This condition is not caused by malposition, strangling, or drowning, but it is probably due to the lack of vitality of the chick. In approximately 70 per cent of these speci-

chicks dead in the shell at full term, and chicks dead in the shell at 15± days of incubation. The abnormalities vary from distorted toes on one or both feet to a total lack of one or both feet (Fig 1). That part



Fig 2 (left) Deformed head of full-term chick with skin removed, (a) normal, (b) deformed

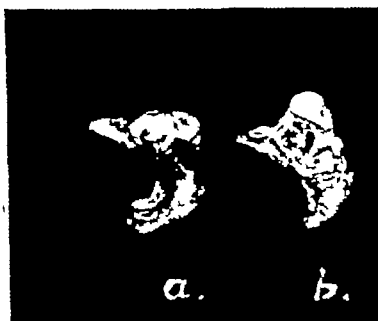


Fig 3 (right) Head with skin removed, (a) normal, (b) deformed

mens, the yolk sac was protruding from the abdominal wall. It may vary from a slight protrusion to a completely extended yolk sac. More than 30 per cent of these chicks are smaller in size than the controls at the time of hatching. Abnormalities of various sorts are common in these chicks.

CHICKS THAT HATCHED

There were 111 birds in this group. The age varied from 19 to 240 hours, and the dosage was from 40 to 600 r. They were equivalent in size to the controls. Approximately 83 per cent of the hatched chicks appeared normal in development and behavior, the remaining 17 per cent were deformed. Most of the apparently normal chicks were raised to maturity for further observation.

ABNORMALLY DEVELOPED CHICKS

Chicks having abnormal development may be divided into four subdivisions: (1) Chicks with deformed inferior extremities; (2) Chicks with deformed heads; (3) Paralyzed birds; (4) Chicks with miscellaneous deformities.

Deformed Inferior Extremities—To this group belonged 34 chicks. They were obtained from three sources: hatched chicks,

of the extremity above the missing members was, to all appearance, normally developed. The reduction in the number and size of the toes was the most common finding in this group of abnormalities. In many cases only one toe or part of a toe remained attached to the metatarsal, tarsal, or in some cases, directly to the tibia. The average age was 53 hours, 48 hours incubation gave the largest number of teratology. The dosage in all, except one specimen, was 400 r. In the exception, the dosage was 240 r and the age 170 hours.

Chicks with Deformed Heads (None of These Hatched)—These deformities appeared to be similar to hydrocephalic malformations, produced by x-rays in mammals (Job, Leibold, and Fitzmaurice, 10). Both the brain and the cranium were enlarged in all dimensions, but particularly in the dorso-ventral axis (Figs 2 and 3). This combination was found in chicks dead in the shell at full term, and at 15± days of incubation. The size of the head varied from slight enlargement to that shown in Figures 2 and 3. The enlargement was not symmetrical in all cases, in some specimens one half of the brain was normal in size and the other half was considerably enlarged. There were eight symmetrically developed hydrocephalic specimens. The

before they were placed on the x-ray machine

CHICKS DYING IN THE SHELL AT 15± DAYS

In this group of 68 eggs were included

pearance, normal chicks Some show various sorts of deformities which will be described later in this paper The age group varied from 19 to 73 hours dosage was from 60 to 400 r

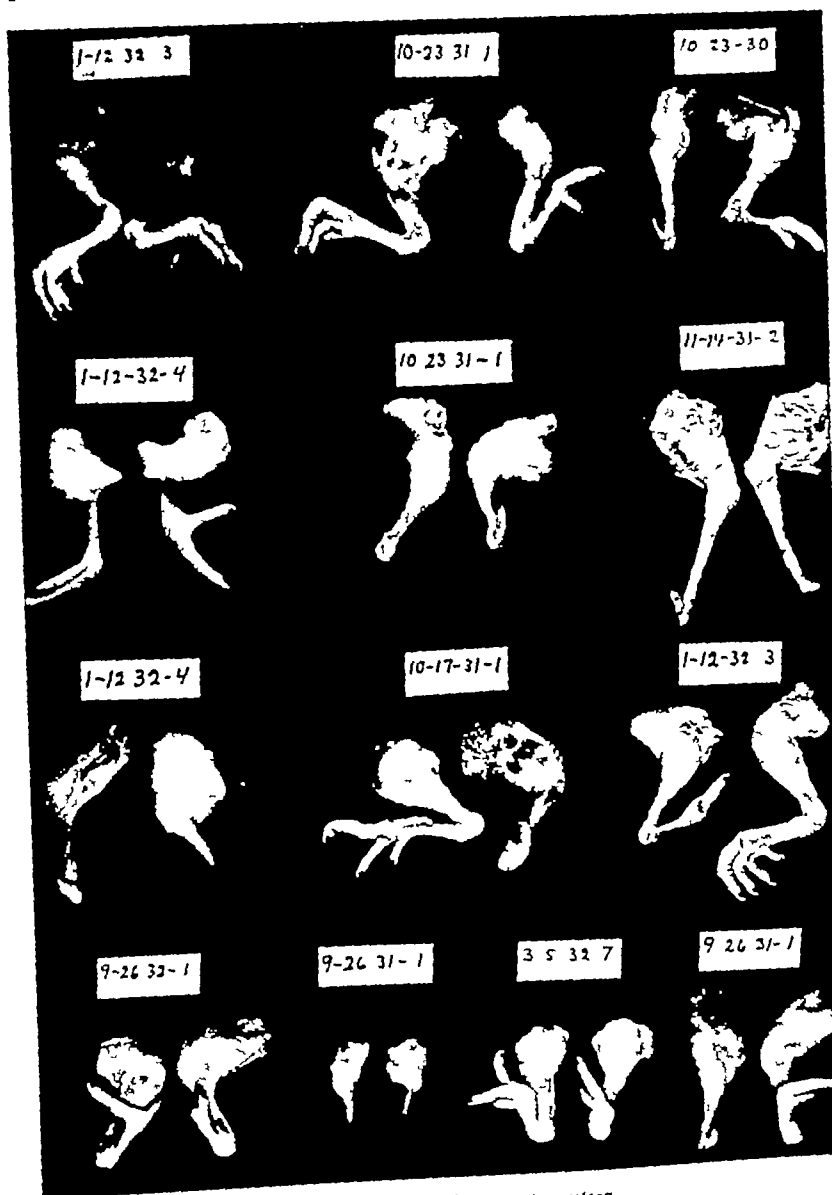


Fig 1 Deformed lower extremities

chicks that had undergone development for several days after irradiation Gross examination of such chicks reveals no cause that would explain their death There were no signs of malposition, strangulation, or other gross deformities to all ap-

CHICKS DEAD IN THE SHELL AT FU
Of these there were 138 eggs varied from 19 to 73 hours, and the dosage was 60 to 400 r The chicks did not have the ability to break the shell and had a few made an opening in the shell b

In Table I, the results of irradiated and control eggs are summarized and the variations expressed in percentages. It will be seen that 45 per cent of all the fertile eggs receiving radiation failed to develop, whereas only 20 per cent of the control eggs failed to develop. The latter 20 per cent is the highest percentage of failure of development of control eggs that have been obtained in this laboratory. This was obtained during the winter period when viability is normally at the lowest.

The best results have reached 100 per cent development. The average obtained in this laboratory as well as that obtained at the supply station, varied between 5-10 per cent. The lowest developmental rate of the control eggs are used here because of the fact that most of this work was done during the winter season.

In the case of embryos dying in the shell at or shortly after radiation, it can be shown that the effect of x-rays on the embryo varies directly with the dosage and inversely with the age (Tables II and III). The same is true of all the groups of the anomalies obtained in this experiment, except that the results are more reliable in cases in which there are a larger amount of experimental animals. In individual cases as well as in several of the groups, consider-

able variation exists in the correlation between results obtained, dosage, and age of the embryo.

A more or less definite correlation was found only in two groups—deformed inferior extremities and paralyzed chicks. In case of deformed inferior extremities, the age was 48 hours, with a dosage of 400 r, and, in case of paralysis, approximately 70 hours incubation with 400 r, which may be regarded as critical periods in the development of the inferior extremities of the chick.

Henn (9) reports a reduction in size of irradiated chicks two-thirds of the normal. In our chicks, in those which died in the shell at full term, there was a protruding yolk sac in 70 per cent and reduction in size in 30 per cent of cases. In the irradiated chicks that normally were able to hatch, no appreciable reduction in size and weight was noticeable. The above discrepancy in the inclusion of the yolk sac and the lesser size was very likely due to the chicks having died in the shell a day or two prior to hatching time and not to the effect of x-rays.

SUMMARY

Five hundred and seventy-two hens' eggs have been subjected to the effects of x-rays at dosages varying from 40 to 600 r, and at ages ranging from 19 to 243 hours.

The results are as follows:

- (1) In 45 per cent of the cases there was little or no development after irradiation.
- (2) In 24 per cent of the cases, chicks died in the shell at full development.
- (3) In 11.9 per cent of the cases, chicks died after development had proceeded for several days (15 \pm days).
- (4) In 9 per cent of the cases, chicks' lower extremities were paralyzed.
- (5) In 6 per cent of the cases, the inferior extremities were deformed. The deformity varying from a distortion of the toes to a total absence of one or both feet.
- (6) In 1.4 per cent of the specimens, there was a hydrocephalic head deformity.
- (7) One per cent of the cases were miscellaneous deformities.

TABLE II—AGE 50 HOURS DOSAGE
VARIABLE

Dosage	No Eggs Rayed	No Eggs Dead	Percentage of Dead
80	5	1	20
240	27	7	26
400	131	70	53
600	14	14	100

TABLE III—DOSAGE 400 r AGE VARIABLE

Age	No Eggs Rayed	No Eggs Dead	Percentage of Dead
19	20	19	95
20-30	26	21	80
31-48	111	55	52
49-80	138	54	39
81-140	24	9	39

average age for this deformity was 128 hours, and the average dosage was 217 r

Paralysis of the Inferior Extremities—

The chicks belonging to this group were unable to walk or stand upright, they moved about by propelling themselves with their wings and beak. Both lower extremities were involved. They were limp, and the toes were usually flexed. The chicks died early owing to their inability to secure sufficient food and water. With some care they could be made to survive, but would show no improvement except in the efficiency of using their wings and beak as a means of locomotion. Other deformities were not usually associated with instances of paralysis, except in one specimen having a distorted neck or torticollis. There were ten paralytic specimens. The average incubation period was 70 hours, and the average dosage was 400 r.

Miscellaneous Deformities—Under this heading were included abnormalities which were known to occur also in the controls. Of such, altogether six in number, there were cases of polydactylism, acrania, and bill and wing deformities. Polydactylism is the most common deformity of this group, but such instances were not more common in the x-rayed material than in the controls. The acrania cases lack the calvarium, the brain was present but small in size. The bill deformities were of various kinds, usually the lower jaw was affected—it may be shorter than the upper jaw or it may be misplaced. Wing deformities were rare among chicks in this flock. Only one case was recorded in which the metacarpals assumed an abnormal relationship to the

radio-ulnar junction, which resulted in turning the tip of the wing outward.

DISCUSSION

The lethal dose of x-ray for white and brown Leghorn chick embryos, with the setup used in these experiments, was close to 600 r. This was apparent by the fact that, out of 29 eggs irradiated with 600 r, only one chick hatched. The age was variable, ranging from 46 to 100 hours.

The effect of the shell and shell membranes on the values of incident x-rays was ascertained in two ways. First, in 63 eggs the shell and its membranes were removed prior to exposure to x-ray. After irradiation the eggs were sealed and allowed to continue incubation. The results obtained from eggs so treated parallel those in which the shell was left intact. The second approach was a direct measurement of rays before and after they had passed through the shell and its membranes by a Victoreen r-meter. By this method it was found that there was a loss of 0.2 r per minute in ordinary dense shells, and 0.4 r per minute in porous shells. This meant that in a dosage of 600 r there was a loss of from 3.33 to 6.66 r. Since very few eggs have porous shells, this loss was very small and not detectable by the first method. Strangeways and Fell (13) report absorption of incident rays by the egg shell to be approximately 40 per cent. This method of measurement or of the calculation was not given in their paper. In passing x-rays through the entire eggs, the Victoreen r-meter showed a loss of 3 r per minute. In view of this, it is difficult to understand the results obtained by the above authors.

TABLE I—COMPARISON OF X-RAYED (572) AND CONTROL (61) EGGS

Results	Irradiated		Controls		Difference in Per cent
	No	Per cent	No	Per cent	
No development	255	45	12	20	25
Hatched	111	20	41	66	46
Death in shell at full term	138	24	5	8	16
Death in shell at 15± days	68	11.9	1	1.6	10.3
Paralysis	10	9	None	None	9
Deformed inferior extremity	34	6	None	None	6
Head deformity	8	1.4	None	None	1.4
Miscellaneous deformities	6	1	3	4.5	-3.5

In Table I, the results of irradiated and control eggs are summarized and the variations expressed in percentages. It will be seen that 45 per cent of all the fertile eggs receiving radiation failed to develop, whereas only 20 per cent of the control eggs failed to develop. The latter 20 per cent is the highest percentage of failure of development of control eggs that have been obtained in this laboratory. This was obtained during the winter period when viability is normally at the lowest.

The best results have reached 100 per cent development. The average obtained in this laboratory as well as that obtained at the supply station, varied between 5-10 per cent. The lowest developmental rate of the control eggs are used here because of the fact that most of this work was done during the winter season.

In the case of embryos dying in the shell at or shortly after radiation, it can be shown that the effect of x-rays on the embryo varies directly with the dosage and inversely with the age (Tables II and III). The same is true of all the groups of the anomalies obtained in this experiment, except that the results are more reliable in cases in which there are a larger amount of experimental animals. In individual cases as well as in several of the groups, consider-

able variation exists in the correlation between results obtained, dosage, and age of the embryo.

A more or less definite correlation was found only in two groups—deformed inferior extremities and paralyzed chicks. In case of deformed inferior extremities, the age was 48 hours, with a dosage of 400 r, and, in case of paralysis, approximately 70 hours incubation with 400 r, which may be regarded as critical periods in the development of the inferior extremities of the chick.

Heim (9) reports a reduction in size of irradiated chicks two-thirds of the normal. In our chicks, in those which died in the shell at full term, there was a protruding yolk sac in 70 per cent and reduction in size in 30 per cent of cases. In the irradiated chicks that normally were able to hatch, no appreciable reduction in size and weight was noticeable. The above discrepancy in the inclusion of the yolk sac and the lesser size was very likely due to the chicks having died in the shell a day or two prior to hatching time and not to the effect of x-rays.

SUMMARY

Five hundred and seventy-two hens' eggs have been subjected to the effects of x-rays at dosages varying from 40 to 600 r, and at ages ranging from 19 to 243 hours.

The results are as follows:

- (1) In 45 per cent of the cases there was little or no development after irradiation.
- (2) In 24 per cent of the cases, chicks died in the shell at full development.
- (3) In 11.9 per cent of the cases, chicks died after development had proceeded for several days (15 \pm days).
- (4) In 9 per cent of the cases, chicks' lower extremities were paralyzed.
- (5) In 6 per cent of the cases, the inferior extremities were deformed. The deformity varying from a distortion of the toes to a total absence of one or both feet.
- (6) In 1.4 per cent of the specimens, there was a hydrocephalic head deformity.
- (7) One per cent of the cases were miscellaneous deformities.

TABLE II—AGE 50 HOURS DOSAGE VARIABLE

Dosage	No Eggs Rayed	No Eggs Dead	Percentage of Dead
80	5	1	20
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600	14	14	100

TABLE III—DOSAGE 400 r AGE VARIABLE

Age	No Eggs Rayed	No Eggs Dead	Percentage of Dead
19	20	19	95
20-30	26	21	80
31-48	111	58	52
49-80	138	54	39
81-140	24	9	39

(8) No appreciable difference in the results were noticed between chicks irradiated with shell and shell-membranes opened and those with shell intact

(9) Eggshell of ordinary density with its membranes absorb 0.2 r of γ -rays per minute

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X-RAYS AND RADIUM IN THE TREATMENT OF TUMORS OF THE CONJUNCTIVA¹

By DR GUSTAV PETER, American Hospital, Mexico City

IN a former paper, published in "Revista de Radiología y Fisioterapia," 1935, and based on 120 cases of cutaneous epithelioma and 12 cases of epithelioma of the conjunctiva, treated with x-rays of different wave lengths, gamma rays, and beta rays, I presented the following conclusions

(1) In working with oscillatory electromagnetic waves of from 10 to 0.16 Ång-

strom unit, a glaucoma developed a few months after the irradiation. Since then I have used a capsule of beta rays (10 milligrams) and a 0.2 mm silver filter in all ophthalmic cases, with the result that no complications have followed any of these treatments. It is supposed that the small penetration of the beta rays has allowed such satisfactory results without complica-



Fig 1-A Case 1, Group I (see table), showing condition on June 1, 1934, Fig 1-B, on June 12, 1934, Fig 1-C, on Aug 15, 1934

strom units for the destruction in general practice of cutaneous epithelioma, no optimum wave length was found, the use of which could be preferred to that of others of the series. In other words, the same results may be obtained with x-rays as with radium under the specified conditions

(2) On the other hand, in comparing oscillatory electromagnetic rays with beta corpuscular rays, the conclusion is reached that in all this group of radiations, including the moderately penetrating gamma rays in the middle of the gamma-ray scale, the beta rays, which are the least used in present-day practice, are the most active

More recently I have had the opportunity to test the practical value of these conclusions due to the following circumstances

In a case of epithelioma of the conjunc-

tiva, cured 14 years ago with x-rays of 0.2 Ångstrom unit, a glaucoma developed a few months after the irradiation

Since then I have used a capsule of beta rays (10 milligrams) and a 0.2 mm silver filter in all ophthalmic cases, with the result that no complications have followed any of these treatments. It is supposed that the small penetration of the beta rays has allowed such satisfactory results without complica-

tions involving deeper tissues, such as the ciliary body and the crystalline lens

Two years ago, on checking the impermeability of my radium containers, I found that the capsule had a microscopic defect, impossible to locate exactly, which allowed the emanation to escape. In order to correct this, I was obliged to seal hermetically the entire capsule in a 0.3 mm silver filter. This resulted in the disadvantage that the filter absorbed nearly all the beta rays, and the intensity was thereby reduced from 15 r to 3.2 r per minute

Figs 1-A to 2-B, inclusive, show two of the 12 cases of conjunctival epithelioma cured with the original capsule. The case shown in Figures 3-A and 3-C was cured with the capsule after it was hermetically sealed in the silver filter

¹ Translated from the Spanish by Mrs. Julia Pet-

Groups I and II, it will be noted that the dosage in Group II is three and a half times that in Group I. Furthermore, three months of almost daily applications were necessary for complete cure, and the patient complained of pain five months after

the total duration had to be increased in using Group II technic is explained by the circumstance that the intensity and the daily fraction was four and a half times less in that group.

In both groups an exudative epidermitis



A B

Fig 2-A Case 2, Group I (see table), showing condition on May 15 1933
Fig 2 B on Aug 1, 1935



A B C

Fig 3 A Case 1 Group II (see table), showing condition on March 1, 1935 Fig 3 B on June 24 1935
Fig 3 C, on June 15, 1935

the beginning of the treatment, in spite of the fact that, clinically, the eye was normal. No other patient has suffered prolonged discomfort.

The fact that the total dosage as well as

developed on the edges of the eyelid in the areas not entirely protected by lead. Using Group II technic, the epidermitis developed in a more pronounced form even before the tumor had disappeared com-



Fig 4-A Case 1, Group III (see table), showing condition on June 20, 1935 Fig 4-B on July 2 1935
Fig 4-C, on Aug 7 1935



Fig 5-A Case 2, Group III (see table), showing condition on July 28 1935 Fig 5-B, on Aug 11 1935
Fig 5-C, on Sept 11 1935

pletely, and lasted a week longer. At the present time (the last of November, 1935), the eye is clinically normal, but the patient still complained of pain in the eyeball during the last week of August.

The increased amount of work for the physician, as well as the trouble for the

patient using Group II technic, prompted me to look for another solution of the problem. I found this by applying the first conclusion mentioned in this paper, *i.e.*, the same results may be obtained by the use of either x-rays or radium.

The two cases of Group III were, there-

TABLE I

	Mu	Kv	Half value layer (calc.)	Filter	Distance	Field	Pause between fractions	$r_{1/2}$ per fraction (calculated in air)	Time per fraction	$r_{1/2}$ per minute	Number of fractions	Total doses per field	Total time for tumor	Total time for series	Number of series	$1/4$ value layer (measured)	Reaction	Reaction time
Group I Capsule Ra dium Beta 10 mg Fractional Irradiation			0.01 Cu equivalent to λ 0.8 Å Al 0.4 mm	0.2 Ag + 0.1 monel	0.5 cm	1 × 1.5 cm	24 hr	150 or 325	10 min or 35 min	15	7	1000 r _{1/2}	70 min	7 days 2 days	1	0 12 brass	Exudative epidermitis erythematous conjunctivitis Duration 1 week	Epidermitis began 14 days after first treatment cured in 4 weeks
Group II Capsule Ra dium B 10 mg Protracted Fractional Irradiation			measured 0.052 Cu equivalent to λ 0.43 Å Al 1.75 mm	0.5 Ag + 0.1 monel	0.5 cm	1.0 × 1.5 cm	24 hr	48 and 64 150 370	15 min + 20 min + 3 hr + 3 hr	3 2	18 + 39 + 8 + 1 — 04	1000 r _{1/2}	1 hr	3 months	1		Exudative epidermitis erythematous conjunctivitis Duration 1 week	Began after 3 months cured in 3 months
Group III X-ray Fractional Irradiation	2.5	44	measured 0.011 Cu equivalent to λ 0.8 Å Al 0.4 mm	no filter	25 cm	1.5 × 2 cm	24 hr	1.0 r _{1/2}	10 min	15	12	1800 r _{1/2}	120 min	2 weeks	1		Exudative epidermitis erythematous conjunctivitis Duration 1 week	Began after 14 days cured in 4 weeks

¹ These cases have been kindly referred to me by Dr. Rafael Silva, Dr. Torres, and Dr. Tezera, Directors of the Ophthalmological Hospital de la Luz, Mexico.

fore, treated with x-rays and cured. The fractional dosage, intensity, field, and half value layer were reproduced as accurately as possible.

After a series of treatments of 12 fractions a day (except Sunday), the tumor presented the typical aspect of destruction, which is characteristic of radium irradiation treatment. A week later, the destruction was almost complete and a slight irritation of the skin had developed on the border of the eyelid in unprotected spots. A week later, both the tumor and the irritation of the skin had disappeared. The course of the disease and the character of the exudative epidermitis were the same as when using Group I technic, and experience of many years has proved that the eyeball as well as the skin can easily stand this treatment.

The technic used in Group III represents a special case of fractional technic, the relatively harmless effects of which on the skin, using shorter wave lengths, have been carefully studied and are well known (Miescher, Borak, and others). Since we know that the dangers of certain dosages of given intensities diminish with the increase in wave length, it is not to be supposed that the exudative dermatitis produced with Group III technic would be more harmful than the epidermitis which we apply without hesitation to cutaneous epithelioma, in spite of the fact that penetration there is greater and the field larger. In epithelioma, we know that this technic is easily tolerated by the skin and that it produces no detrimental after effects.

The similarity of the technic used in Groups I and III permits the hypothesis that, for the ocular bulb, the ciliary body, and the crystalline lens, especially, the effect is the same.

On comparing the technic of Groups I and III, it is noted that the total dosage with x-rays had to be greater than the dosage with radium (x-rays, 1,800 r—radium, 1,000 r). In addition to this, two weeks were needed for the x-ray treatment, whereas the same result was accomplished with radium in half that time. This fact

supports the second conclusion mentioned above, *i e*, that the corpuscular rays are more active than the oscillatory rays

These clinical observations naturally must be corroborated by exact physical methods. The ionization chamber of the Mekapion, with which the measurements were made, is guaranteed for wave lengths of from 70 to 220 kilovolts. The γ -rays used were 44 kv, corresponding to a half value layer of 0.01 copper (0.8 Ångström unit). The half value layer of the radium capsule before its repair had only been calculated at 0.01 copper. The direct measurement at the important moment of discovering the defect was not possible, due to the danger of re-charging the ionization chamber with emanation. For these reasons, one cannot overlook the possibility that the smaller total dose necessary in the radium treatment may be explained by less

penetration than that calculated, or in other words, by more absorption in the wall of the ionization chamber

CONCLUSION

Epithelioma of the conjunctiva may be cured with γ -rays as well as with radium, by using a technique which differs only in minor details of small, practical, or economic importance

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EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

INFORMATION CONCERNING THE NATIONAL HOUSING ACT AS IT MAY AFFECT RADIOLOGISTS

The National Housing Act which is being administered by the Federal Housing Administration was designed to be of help to the professional and scientific man as well as the layman, the small home owner, the man in business and industry.

The regulations under which it is easy to get insured modernization credit are so attractive that the radiologist, or other specialist whose establishment may be in need of modernization, repair, or new equipment essential to the conduct of his practice, should be familiar with the provisions.

First it should be explained that it is possible to get insured credit for as much as \$50,000, or for a few hundred, depending upon the need and the credit standing of the borrower. The carrying charges may never be in excess of the equivalent of a 5% discount for each \$100 face value of a one-year monthly installment note. The loan is to be repaid in equal monthly installments and may be spread over a period of as long as five years.

The Federal Housing Administration does not lend the money. The transaction is made through ordinary banking channels with banks which have entered into contracts with the Federal Housing Administration, under which the administration insures them against loss up to 20 per cent of the total of such loans. There are one or more such institutions in practically every community in the United States.

The arrangement is so attractive that banks ordinarily are more than willing to extend the accommodation and it is now easy to get the required credit in instances in which it has been difficult if not impossible during the period of the depression.

The essential requirements are that the lending agency must consider the applicant a good credit risk and must be satisfied as to security in instances in which security is considered advisable. This is because the banker instead of the government makes the loan.

The question of the type of equipment which would be considered eligible for a loan may in

many instances be answered by the dealer or his representative. Broadly, it would include the installation of non-portable and durable character—sufficiently so to outlive the period of the loan.

Rulings have already been made that the following are eligible for loans:

X-ray machines, x-ray generators, fluoroscopes, certain types of deep therapy equipment, certain types of x-ray dosage measuring equipment, x-ray tilt tables, horizontal x-ray tables. Equipment of this type would ordinarily be considered eligible.

In instances in which there is any doubt as to eligibility, suggest to the dealer that he send a complete description, with photographs, to the Federal Housing Administration, Washington, D.C., for an official ruling.

Scientists or professional men who maintain their offices in residences are limited to a loan of \$2,000. Those who have offices in office or apartment buildings may obtain larger sums, if the banker approves.

Medical men who maintain jointly a clinic or diagnostic center may find it desirable and profitable to modernize and repair the structure (loans for this purpose are usually eligible) and to install the latest devices essential to modern practices.

The legislation, as explained, took this into consideration when it included hospitals in the list of properties upon which large loans may be made.

Another and final point is that the loan is in cash for the full amount, so that purchases and repairs or modernization may be made on a cash basis with the benefit of the cash discount.

IN MEMORIAM

BUNDY ALLEN, M.D.

When members of the Radiological Society of North America gathered for their 1935 Annual Meeting, they were shocked and saddened to hear of the death, a few days before, of their

friend and past president, Bundy Allen. He was the victim of a collision between his car, driven by himself, and a bus, the latter being used by a party returning from a fishing trip.

Bundy Allen was born Aug. 21, 1885, at Carbondale, Illinois, in which town he received his elementary schooling. He took a pre-medical course at the University of Indiana and re-



The late Bundy Allen, M.D.

Dr. Allen lived more than twenty-four hours, but did not regain consciousness, the skull fracture which he suffered was of so serious a nature that the physicians in attendance knew that the chance of his recovery was slight. His eleven-year-old son, Joseph, who was in the car with him when the bus struck his car, was not seriously hurt.

He received his M.D. degree in 1912 from St. Louis University, at St. Louis, Missouri. After practicing medicine for two years in that city, he went to the University of Iowa, at Iowa City, where he was head of the Department of Roentgenology for eleven years. He married Miss Edith Cochenour the same year he took his degree in medicine. In 1926 Dr. Allen and his

family moved to Tampa, Florida, where he confined his practice of medicine to the specialties of roentgen ray and radium work.

Dr. Allen was a member of his local, state, and national medical societies, the Radiological Society of North America (charter member), the American Roentgen Ray Society, the College of Radiology, and the British Institute of Radiology, of England. He was formerly Associate Editor of *RADIOLOGY*. His active interest was manifested in civic associations and social welfare organizations in his home city.

His loss is felt keenly by his friends, and the grief felt over his untimely death is deep and genuine.

HARRY B. PODLASKY, M.D.

Harry B. Podlasky, M.D., died Sunday afternoon, Nov. 3, 1935, of coronary thrombosis. The attack was entirely unexpected since he had never had any symptoms of coronary artery disease. He was 52 years of age. For his intimates, his death was a shocking calamity, and by his many friends throughout this country his passing was deeply felt. He is survived by his wife and daughter, who have no small comfort in the tokens of kindly and sympathetic appreciation from an almost unsuspected host of friends.



The late Harry B. Podlasky, M.D.

"Pod," as he was affectionately known, did not leave a great monument of medical achievement in the sense of accomplished research or extensive bibliography. He was always active, however, in radiological circles, and his handsome figure and vigorous personality lent color and dignity to medical gatherings. He was a member of both of the great national radiological societies, and recently had become a Fellow of the American College of Radiology and a diplomate of the American Board of Radiology. In Wisconsin, his activities in the State Section of Radiology, Milwaukee Roentgen Ray Society, and Milwaukee County Medical Society were always in the interests of the profession. He founded and directed the Department of Radiology at Mount Sinai Hospital, Milwaukee. Into Mount Sinai Hospital went energy, enthusiasm, and devotion of a kind and degree not given to any of his other interests. For him, this hospital loomed as the hub of his medical community, and he visualized it as a source of energizing medical training and education for the novitiates in medicine.

He fulfilled the destinies of the true physician by his activities as a teacher, being head of the Department of Radiology at Marquette University and Editor of the section on x-ray of the "Wisconsin State Medical Journal."

As a radiologist, his *forte* was in the field of diagnosis, and it may certainly be said that he possessed not only diagnostic ability of a superlative degree, but, coupled with that, knowledge of medical practice inherited from his years of general medicine before specializing in radiology. He strongly felt the need for radiologists to have at their command a broad concept of medicine and sound training in pathology and physiology. He frequently laid the shortcomings of specialists in his field to the lack of a broad medical education. His friends frequently criticized him for his almost ultra-conservative readings of diagnostic investigations. Of late years he was prone to call attention to the tendency for medicine to develop away from the arts and to adopt methods of accuracy, and in that regard, radiology in his opinion needed scientific control, and he much deplored the abuses of both the science and the practitioners of radiology by commercializing and economic influences. He was a vigorous protagonist of the development of the specialty under national advisement, and strongly felt that the difficulties and problems besetting this division of medicine could be solved satisfac-

torily only by national organization. He was among that small group who were willing to accept the brunt of sacrifice in the defense of a principle. A vigorous champion of personal and group rights, radiologists have lost in him a man of idealism and practical common sense. For him, medicine was a religion. Ethics, right living, and right behaving had only one meaning. In his teaching, it was not enough for him to teach subject matter, but always he had in mind the teaching of the conduct of practice to students and recent graduates. He exalted the profession of medicine. Jefferson Medical College, from which he was graduated in 1909, may well be proud of Harry Bernard Podlasky.

NORBERT ENZER, M D

ANNOUNCEMENT

Harper & Brothers announce that they have acquired the medical book publishing business of Paul B. Hoeber, Inc. A program of expansion is planned, and medical books will be published under the imprint of Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers. Mr. Paul B. Hoeber, the founder, remains in charge of this department.

Paul B. Hoeber, Inc., was established in 1901 as a medical bookstore. The first book published under the Hoeber imprint—Ehrlich's "Specific Therapeutics"—appeared in 1909. Since then it has pioneered in the publication of authoritative medical books which have been noteworthy also for their fine manufacture. The firm is well known for its series of Medical Monographs, which includes works by Francis R. Packard, Hugh H. Young, David Riesman, Sir Humphry Rolleston, Frederick Tilney, Charles A. Elsberg, and other authorities. It has specialized in medical history, and established in 1917 the "Annals of Medical History," internationally known as the outstanding publication of its kind. Among the eminent books which have appeared under the Hoeber imprint are "The Brain from Ape to Man" by Frederick Tilney, "Nervous Indigestion" by Walter C. Alvarez, "Pediatrics of the Past" by John Rurah, and the "Annals of Roentgenology" of which sixteen volumes have been published to date.

BOOK REVIEWS

SYMPOSIUM ON SILICOSIS An Unofficial Transcript of the Silicosis Symposium Held in Connection with the Trudeau School of Tuberculosis at Saranac Lake, New York, June 18 to 22, 1934. Edited by B. E. Kuechle, Claims Manager, Employers Mutuals, Wausau, Wisconsin. Introduction by Dr. Leroy U. Gardner. Paper-bound volume of 99 pages and no illustrations. Published by The Storey-Bellack Company, Inc., Wausau, Wisconsin, 1934. Price \$5.00.

The book containing the unofficial transcript of lecture notes taken during the Silicosis Symposium at Saranac in June, 1934, is a small one but of great value. Each lecturer approved the notes of his lecture before it went to press. It is important to note that the financial returns are being given to the laboratory at Saranac for research on silicosis.

The form is that of abstracts of the papers given at the conference, and the discussion of those papers. It is unusually well written, very brief, and very readable. The contributors to the conference were men of ability who had real contributions to make. As a result of these contributions, the various types of silicosis can be recognized, the progress of the disease understood, the treatment improved, and its prevention made possible.

On the whole, this book is the most constructive piece of work on silicosis that has ever been attempted and brought to a conclusion. It should be read and studied by every radiologist, every clinician interested in diseases of the chest, and every physician who comes in contact with industrial medicine.

DIE KLINISCHE RONTGENDIAGNOSTIK DER INNEREN ERKRANKUNGEN By DR. HERBERT ASSMANN, Professor and Director of the Medical Clinic and of the University of Königsberg. Fifth Edition. With 1248 pages, 1216 illustrations, and 10 tables. Parts I and II. Published by Julius Springer, Berlin, 1934. Price Rm 87, bound, Rm 95.

This well-known text-book, which has served for instruction and reference in the hands of many young and old radiologists and physicians all over the world, has been reprinted in its fifth edition. The author, who is a Professor of Internal Medicine at Königsberg, Germany,

has succeeded admirably in presenting that field of roentgenology which concerns internal medicine. For the radiologist it is of particular interest to see in what way a man, whose specialty is internal medicine, uses the roentgen rays, the approach being clinical primarily, and roentgenological secondarily. For the general diagnostician these two volumes, with 1248 pages, represent a connecting link between medicine and roentgenology, to read this book might be easier for him than to study a book of roentgenology written by a radiologist.

Volume I (466 pages) contains the chapter on the heart and blood vessels, mediastinum, lungs, pleura, and diaphragms. The normal roentgen appearance and the question of determining actual heart-size are related in detail. Pathological changes in size and contour are discussed at great length. The recent, much-talked-of kymography is mentioned, and some newly described roentgen symptoms, valuable in the diagnosis of heart diseases, are quoted, such as aneurysms of the heart, tumors of the heart, and calcification of the valves. The aorta and its roentgenologically demonstrable diseases are allocated 30 pages and not much more could be said to complete that subject. Arteriography takes up only a few lines.

The mediastinum and its pathology is dealt with adequately but probably not as extensively as the material on the heart.

The treatise on the lungs, pleura, and diaphragms might constitute a book in itself. One misses the mention of a vena azygos lobe in the lower lung-fields, which has been described recently. It is interesting to note that massive atelectasis is related only by quoting the literature, and that the reproductions of two chest films, showing this condition, are taken from Sante's book, "The Chest." It would appear from this that such a condition is not commonly recognized in Europe, for it is certainly not rare in the United States. Many pages are devoted to a fully sufficient description of the roentgen signs of all stages of tuberculosis. However high the author's regard is for the outstanding importance of roentgenography, he still insists on the extensive use of all clinical diagnostic means, especially for the question of activity and prognosis. Unusual and rare diseases of the lungs are mentioned, but their description is hardly detailed enough to make this section useful as a reference. All one wants to know about the radiological features of diseases of the pleura

and diaphragm will be found in these respective chapters.

Volume II deals extensively with diseases of the gastro intestinal tract (325 pages), the other abdominal organs, the urinary tract, the nervous system, bones, joints, and muscles.

The roentgen examination of the esophagus is treated proportionately. It is interesting to note that the author calls the diagnosis of gastric diseases by means of multiple films, the American method, while the preference for fluoroscopy is called the Vienna method. Apparently, he does not know that the procedure of Cole is not generally followed at all throughout the United States, and that many American examiners put a higher valuation on fluoroscopy than on films. The author, himself, prefers a combination of both. Considerable attention is paid to functional changes of the stomach. Organic diseases are examined for the roentgenological equivalent of the pathological features mainly, and so-called secondary signs are considered of only secondary importance. Cholecystography receives the description which it deserves. A clinical syndrome of ptosis and atony of the gall bladder is held doubtful, but it is stated that adhesions may often be demonstrated, especially when the gastro intestinal tract is filled by barium.

Methods used in the examination of the urinary tract are presented in a way which suffices for the field of internal medicine.

Roentgenology of the skull (including a special chapter on encephalography) gives the reader a general outline of the value of this method. It is mentioned that in exceedingly rare instances, spinal cord tumors might lead to roentgenologically demonstrable erosions of the vertebrae. The important contribution of Camp, of the Mayo Clinic, who found this true in a high percentage of cases, is not quoted.

Only those diseases of bones and joints that concern internal medicine are described, and yet, the chapter contains about 140 pages.

It seems an almost unbelievable achievement for one man to master the entire field in such a remarkable way. Certainly the character of such a text-book is more individualistic than one containing contributions of several authors. The German literature is quoted extensively, while the literature in other languages is related very sparsely and makes up less than 5 per cent of all quotations. Thus, some very important American contributions have been missed.

For any physician who specializes in roentgenology or internal medicine and who reads the German language, this work is to be recommended as highly as ever. It is the modernized Assmann, truly bigger and better.

THE 1935 YEAR BOOK OF RADIOLOGY *Diagnosis*, edited by CHARLES A. WATERS, M.D., Associate in Roentgenology, Johns Hopkins University, Assistant Visiting Roentgenologist, Johns Hopkins Hospital. Associate Editor WHITMER B. FIOR, M.D., Assistant in Roentgenology, Johns Hopkins Hospital. *Therapeutics*, edited by IRA I. KAPLAN, B.Sc., M.D., Director, Division of Cancer, Department of Hospitals, City of New York, Director, Radiation Therapy Department, Bellevue Hospital, New York City, Director, New York City and Brooklyn Cancer Institutes, Associate Radiologist, Lenox Hill Hospital, New York City, Clinical Professor of Surgery, New York University Medical College. With 580 pages and 619 illustrations. Published by The Year Book Publishers, Inc., Chicago, Illinois, 1935. Price \$4.50.

This annual review of the current radiological literature in its short period of existence has so established itself that its appearance each year provokes the same satisfaction as the coming of a favorite magazine. Notwithstanding the objections to short-cuts to knowledge, no individual who is seriously interested in the advancement of radiology can peruse this year book without profiting much thereby and deriving an added stimulus for his work.

A review of the diagnostic section of this volume emphasizes even better than its predecessors that this branch of radiology is living in the 'injection era' and with the progress that has been made to date with radiopaque substances, future revelations are interesting to speculate about. Santos' unique work on the visualization of peripheral nerves and their pathologic changes (neurography) is an excellent example of what may be expected.

Although no unusual developments in radiation therapy occurred during the year the literature concerning this phase of radiology was profuse. It is evident that this branch of radiology is suffering from voltage "growing pains." "It is, however, a moot question whether x-rays generated by superpowered apparatus have greater therapeutic potency than those of the usual kind, generated by the 200 kv. apparatus." Wright's lecture on the value of pre-operative radiation for breast

cancer and Crossen's declarations that "radiation is the treatment of choice for carcinoma of the cervix" and that "surgery should supplement, not displace, this more desirable procedure" are two contributions of note.

An adequate review of the entire volume is obviously impossible because of its nature. Needless to say the authors have condensed the current radiologic literature in a manner that should insure the popularity of this work. The illustrations are profuse and excellently reproduced.

THE DOCTOR'S BILL By HUGH CABOT. With an introduction by A. Lawrence Lowell. A volume of 313 pages and no illustrations. Published by Columbia University Press, New York, 1935. Price \$3.00.

The title of this book sounds far more popular than the contents will be to the average physician who is trying to collect his bills. This is a philosophic treatise upon the trends in methods and practice. It is quite different in its viewpoint from the book by Christie (*Economic Problems in Medicine*).

The medical profession recognizes Hugh Cabot as an illustrious medical representative, administrator, and urologic surgeon. The name of Cabot is great in medicine, whatever direction is pursued. The introduction by A. Lawrence Lowell, formerly president of Harvard University, is a further guarantee that the conservative, God-communicating sequence has been preserved.

The title is somewhat misleading because the substance of the book takes a far look into the trends of medical practice. The viewpoint is more philosophical and detached than practical. One should not say that it is impractical but certainly the book offers little comfort to those of us who are harassed by the economic problems of the moment. It finds flaws rather than faults with the activities of the Bureau of Economics of the American Medical Association. The book is not anti-social or anti-American Medical Association. It is just a cold analysis of medical trends and Cabot seems to believe that things are going to be different—in fact, quite different—as the inevitable turning-tables of social organization are applied to medical practice.

Cabot quotes time and again from Sir Arthur Newsholme, the eminent English public health protagonist. Sir Arthur has a good reputation but his American debut and subsequent

periences were devised by the lately developed *Kingsbury of the Milbank Fund*. Unquestionably this has interfered with the proper reception of Sir Arthur's ideas by the American profession. No less an individual than the great Welch, of Hopkins, was sponsor, partisan, and friend of Sir Arthur. But whatever influence Sir Arthur's visit had on America, he has failed to provoke any echo or chorus of praise by organized medicine here.

Of course the average American physician looks no farther than the end of his nose for the solution of an economic problem. Therefore, in choosing the accessible hay of the moment he may be missing the great pasture of perpetual nourishment. In spite of the resolving of county, state, and national organizations in medicine, there are inevitable changes that are now in the process of sedimentation. The waters are stirred unreasonably and beyond all ocular vision of immediate solution. The dough is in the kneading, the leaven cannot be measured. How far are the present activities in so-called social security going? Will they engulf the established methods of individualistic and collective group methods of practice? Will they demand the regimentation of medicine to the extent that police protection, public education, water supply, and fire protection now enjoy compulsory taxation?

Cabot's concluding chapter is entitled, "Where do we go from here?" The theme of his message is "he that pays the piper, calls the tune." Therefore, the taxpayer gets far more house from Cabot than the theme songs of 1934-1935 American Medical Association meetings grant. Cabot feels that in meeting the demands of science, medical organization has progressed to an adequate extent, but that there has been failure to recognize the problem of social medicine, therefore, the profession is now suffering from the folly of its own neglect. Cabot constantly reiterates his concern for the public interest. He believes that physicians should be paid for their care of indigent and semi-indigent patients by state payments, taxation and by collective subsidies for workman's compensation, industrials, poor, geographical population groupings, etc. Cabot does not fear, but rather encourages, the introduction of laymen into medical groupings, boards, committees, etc., to provide stability (in finances) and register public opinion. He favors more and better public health personnel, nurses and social workers and a larger active participation by physicians.

Cabot does not argue for state medicine. Rather, does he analyze the inadequacies of medical organization toward what he considers the inevitable demands of public interest. Therefore this may be considered as the viewpoint of a physician whose family training and life have been ultra-conservative, and that it records his reactions to the clamor of propaganda and foundations and to the alleged stubbornness or short-sightedness of organized medicine. Cabot discusses the trends toward social security and the wider distribution of the benefits of invention, research, and what we are now calling civilization. It is not an antidote to Christie's book. Rather, is it a bitter pill, and here's hoping that the profession is not jaundiced and don't need it. But it is written by a Cabot and you cannot just rub it off your list.

RADIUM TREATMENT OF SKIN DISEASES, NEW-GROWTHS, DISEASES OF THE EYES AND TONSILS. By FRANCIS H. WILLIAMS, M.D. (Harv.), S.B. Massachusetts Institute of Technology, Senior Physician Boston City Hospital, Fellow American Academy of Arts and Sciences, Emeritus Member Association American Physicians, Member Société de Radiologie Médicale de France, Corresponding Member K. K. Gesellschaft der Aerzte in Wien, Honorary Member American Radium Society, American Roentgen Society, Radiological Society of North America, etc. Author 'The Roentgen Rays in Medicine and Surgery' (3 editions), 1910-1903. Bound volume of 118 pages, 12 figures. Published by the Stratford Company, Boston, Mass., 1935. Price \$2.00.

This is a small, concise volume. The text is presented in an interesting manner, interspersed with many case reports and photographs of instruments designed by the author for the radium treatment of eye and throat lesions. The ophthalmologist and laryngologist will find several valuable therapeutic suggestions for problems in their domain. The radiologist, however, will especially esteem the book for its historical and inspirational value. The author is one of the true pioneers of radiology and describes many of his early researches and methods of measurement. His enthusiasm for radium therapy after thirty years of experience is a testimonial to the value of radium in medicine and is also an equal testimonial to the painstaking and conscientious life work of the author.

LEISTUNG UND GRENZEN DES RONTGENVERFAHRENS BEI DER ERKENNUNG TUBERCULÖSER LUNGENVERÄNDERUNGEN (The Accomplishments and Limitations of the Roentgen Method in the Study of Tuberculous Lung Changes) A comparative roentgenologic, clinical, and anatomic study By Priv-Doz DR WALTER SCHMIDT, Director and chief physician of the Tuberculosis Hospital, Heidelberg-Rohrbach With the collaboration of Priv-Doz DR H WURM, Prosector, Pathologic Institute, Heidelberg A volume of 80 pages and 104 illustrations Published by Johann Ambrosius Barth, Leipzig, 1935 Price Rm 10

This small monograph, with only 26 pages of text but with 104 excellent illustrations, presents a correlation of the roentgen and autopsy findings in a series of 170 well-studied cases of pulmonary tuberculosis. It is Schmidt's purpose to supplement the original work of Graf and Kupferle, in this same field, by bringing to it the knowledge of tuberculosis gained during the past decade, and particularly to add studies of the early adult lesion which were not covered in their monograph.

The introduction by Dr Wurm details the method of preparation and study of the pathological specimens and their comparison with the roentgenograms made during life. By this means the authors are enabled to present authoritative data on the significance of the roentgenographic findings in a variety of tuberculous processes.

The discussion includes detailed comment on the following: old childhood infections, the early adult lesion, the question of endogenous or exogenous origin of adult lesions, the possibility of the roentgen diagnosis of various pathological states, the recognition of the early cavity, the findings in old cavities, the significance of the roentgenographic findings in prognosis, the importance of proper roentgen technique.

There is little in this monograph that is unfamiliar to the American roentgenologist or phthisiologist. Nevertheless, there is presented abundant confirmation of many relatively new ideas which in itself makes the book worthwhile. The material is presented most concisely so that there is a great deal of meat in the few pages of text. Particular attention may be called to the author's classification of tuberculous lesions and to the detailed discussion of the early adult tuberculous process (*frühinfiltrat*). The data on the development, diagnosis, and differentiation of early tuberculous cavities are also of unusual interest. The statements on the value of roentgenoscopy, x-ray paper, stereoscopy, and serial roentgenography are of considerable value, although

many of the author's conclusions will not be generally accepted.

THE RADIOLOGY OF BONES AND JOINTS By JAMES F BRAILSFORD, M D (B'ham), M R C S (Eng), Radiological Demonstrator in Living Anatomy, the University of Birmingham, Honorary Radiologist to the Queen's Hospital, Birmingham, Honorary Radiologist to the Royal Cripples' Hospital and the Warwickshire Orthopedic Hospital, Radiologist to St Chad's Hospital and the City of Birmingham Infant Welfare Centers, Late Radiologist, the Birmingham War Hospitals and Ministry of Pension Hospitals. Fabrikoid binding, 500 pages and 310 illustrations. Published by William Wood and Company, Baltimore, 1934. Price \$9 00.

Extensive radiologic experience, knowledge of clinical medicine, and a keen appreciation of relative values are apparent upon every page of this beautifully printed and excellently illustrated volume. Furthermore, the index is splendid and this is always appreciated by those who consult a book for help upon both the usual and unusual in roentgen practice. A good index does not always secure the praise deserved, but a bad index can banish an otherwise useful book to oblivion. Even the table of contents is extensive and valuable in Mr Brailsford's book.

The author devotes an ample chapter to the discussion of each of the ordinary anatomical divisions and joints of the skeleton, lists and discusses the usual deformities, congenital and acquired, together with the pathological displays which are characteristic. The sense of values of the author is apparent when he devotes four chapters to the spine, its deformities, congenital variations, and pathological vagaries.

The author has certainly completed his ambition to describe and illustrate bone changes in health, deformity, and disease, to indicate the significance of the roentgen evidence and to record the advances in roentgenology that up to this time have been present only in the journal literature.

The reviewer can remember picking up this book at a publishers' exhibit and then replacing it upon the rack as just another book on roentgen interpretation. But, upon looking through it for reviewing purposes, he was so impressed with the completeness of the roentgen information that he found himself reading whole chapters. In an attempt to discover some weakness he could discover only an absence of parathyroid calcium deficiency discussion. This is, however, not a real weakness because the subject is not settled, it is only muddled by the

madequacy of final information and clinical support of the original contentions of early contributors. So Mr Brailsford is probably correct in omitting this controversial subject.

If any practising roentgenologist possesses Kochler's volume upon the borderline of the normal and abnormal in "Roentgenology" and

Geschickter and Copeland's tome on "Bone Tumors" and now adds Brailsford's "Radiology of Bones and Joints," he will have completed his library for bone displays upon the roentgen-ray film. Of course, to-morrow may provide another and all-comprehensive volume, but until to-morrow comes let us rest content with the possession of this excellent book.

ABSTRACTS OF CURRENT LITERATURE

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S M ATKINS M D, of Waterbury Conn	H A JARRE, M D, of Detroit Mich
J E HABBE M D, of Milwaukee, Wisc	ERNST A POHLE, M D, Ph D of Madison, Wisc
HANS W HEFKE, M D, of Milwaukee Wisc	E M SHEBESTA, M D, of Detroit, Mich

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APPARATUS

Tomography II (Theoretical Considerations) G Grossmann *Fortschritte der Röntgenstrahlen* 1935 51, 191-208

Geometric and physical deliberations of the various technical and practical tomographic propositions. This paper should be read in the original by those interested in the subject.

H A JARRIS M D

CANCER (THERAPY)

Cancer of the Cheek (Buccal Mucosa) Study of 99 Cases with Results of Treatment at the End of Five Years. Hayes J Martin and Otto H Pfluger *Arch Surg* May, 1935 30, 731-747 (Reprinted by permission from *British Med Jour* Sept 21, 1935, p 44 of *Epitome of Current Medical Literature*.)

The authors review 99 cases of carcinoma of the cheek which occurred in the five year period from 1925 to 1929. The series included all cases, however advanced in which there was histologic proof of the presence of cancer, and the end results are based on the histories of patients observed for five years or longer.

Cancer of the cheek is chiefly a disease of old age and is nine times as frequent among men as among women. The mid portion of the cheek, opposite the occlusal level of the teeth is the most common site although the disease may appear anywhere on the buccal mucosa or in either of the buccogingival grooves. Direct local extension of the primary growth into the adjacent soft parts may take place at an early stage of the disease and was seen in over 60 per cent of cases. Chronic irritation to the buccal mucosa by sharp or broken teeth, ill fitting dental appliances, syphilis and tobacco is the most obvious etiologic factor in carcinoma of the cheek. There was evidence of dental irritation in 23 cases. Leukoplakia was found in about 70 per cent of cases.

Cancer of the cheek is found to be epidermoid carcinoma in 95 per cent of cases. The disease is symptomless in the early stages and appears at first as a small ulcerated indurated mass which may or may not protrude above the surface of the mucosa. Unless the lesion begins in the center of the cheek the tendency is toward an early invasion of the upper or lower jaw, the lateral pharyngeal wall or the palate. As the tumor enlarges it becomes fissured and necrotic in section takes place followed by swelling of the cheek and tenderness or pain. Metastasis, usually to the submaxillary lymph nodes, occurs comparatively late in the course of the disease.

The most successful treatment was found to be a combination of irradiation and surgical intervention. Of the group under review 28 patients have been free from disease for from five to eight years.

The Relative Value of Surgery Radium and Roentgen Therapy in Carcinoma of the Breast. Isaac Levin *Am Jour Roentgenol and Rad Ther* January, 1935 33, 59-70.

Surgery, radium and roentgen therapy are the only

methods in our possession for treating cancer of the breast. The modern methods of radical surgery in cancer of the breast represent a great advance over the old methods. However, even with the latest methods of surgery not more than 10 per cent of all patients remain well five years after operation.

In view of the small percentage of the successful cases, it is advisable not to differentiate so severely between radical and palliative surgery on the one hand, with the indications for surgery and, on the other, use less extensive methods of operating. Surgery should not be considered as the only therapeutic method but rather as an indispensable adjuvant to radiotherapy. Electrosurgery may improve the surgical results.

Radiotherapy is the nearest to a specific remedy we possess in cancer and is, from this standpoint, superior to surgery and has a wider applicability. Limitations of radiotherapy are of such a nature as to be frequently overcome by a correct co-ordination with surgery.

S M ATKINS M D

CARBUNCLES

Roentgen Treatment of Carbuncles. Whitmer B. Frior *Am Jour Roentgenol and Rad Ther* January, 1935, 33, 71-74.

In the past three years the author has treated 56 carbuncles with x-ray therapy and produced like many other roentgenologists brilliant results. He deprecates the surgeons and physicians failure to use this method of treatment more frequently and believes their apathy due to ignorance of it. Only one of these cases failed to respond and required surgical excision, which failed to save the patient.

Roentgen rays of 127-150 kv with 0 to 3 mm Al were employed depending on the depth of the lesion. From 200 to 250 r were applied as the initial dose and from 100 to 150 r in a day or two if proper reaction had not occurred.

The usual course of events were intensification of pain and elevation of temperature two to three hours after treatment followed by marked relief of pain within a few hours, disappearance of induration and sharp localization of the lesion in from 24 to 48 hours, drainage through a single opening and general subjective improvement. The acute inflammatory phase of the lesion usually subsided entirely in about two weeks and the resultant scar was very slight—some were completely aborted.

This treatment should be instituted as early as possible. In every case the patient is kept under surgical observation for other steps when necessary—usually only for very slight incision.

S M ATKINS M D

DIATHERMY

Deep Effect and Localization in the Short Wave Condenser Field. F Nagelschmidt *British Jour Radiol* July 1935 8, 449-456 (Reprinted by per

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mission from British Med Jour, Sept 21, 1935, p 45 of Epitome of Current Medical Literature.)

Prominent difficulties in the technic of short wave therapy are according to this author, that the condenser field suffers deformation by the introduction of any object into the field between the two electrodes, the intense radiation which emanates in all directions from the electrodes the wires, and the patient, and the absence of any practical measuring device. He believes that he has been able to overcome the first two of these sufficiently for practical purposes. He interposes suitably shaped auxiliary dielectric electrodes in order to concentrate the majority of the power of the whole field energy to a desired part of the portion of the body to be irradiated. Contact with the auxiliary electrodes (with or without a small air space between the metallic pole plates) and the dielectrics reduces considerably radiation losses by its damping effect. The size of the metallic pole plates can be relatively small. The dielectric employed (a glass tube containing white of egg) brings about an exact localization of the heating. When the size or form of the part to be irradiated is unsuitable the difficulty can be surmounted by the introduction of auxiliary electrodes of wax-paraffin mixtures or agar with certain admixtures.

DOSAGE

The Testing of the Calibration of Small Chamber Dosage Meters. G. Spiegler and K. Jurs. *Strahlentherapie*, 1935, 54, 174-181.

The authors found that tests used so far for the calibration of small ionization chambers do not satisfactorily detect variations due to changes in atmospheric pressure and temperature. Errors in dosage may be as high as 10 per cent. They constructed therefore, a new standard of comparison based on beta radiation of radium which indicates changes proportional to fluctuation in pressure and temperature.

ERNST A. POHLE, M.D., Ph.D.

ENDOCRINE GLANDS

Roentgen Examination in Endocrine Pathology. J. Morelle and H. Solé. *Jour de Radiol et d'Electrol*, July, 1935, 19, 360-400. (Reprinted by permission from British Med Jour Sept 21, 1935, p 45 of Epitome of Current Medical Literature.)

The authors review comprehensively the part which radiology may play in elucidating diseases of endocrine etiology. Thus diminution of the normal transparency of the pituitary suggests calcareous impregnation, while granular concretions may be recognized in its fossa or changes in its immediate neighborhood affecting the bone or brain. Early calcification may similarly be recognized in the pineal gland but must be differentiated from calcareous changes in the choroid plexuses which are generally bilateral and give ring-shaped shadows. Intra parenchymatous calcareous deposits may also be seen in the thyroid gland especially in adenomatous degeneration. Thyroid hypertrophy appears as a diffuse shadow and retrosternal extension

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HANS W. HEFKE, M.D.

FEVER THERAPY

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Upon this basis, 32 hopelessly advanced human cases of different types of malignant disease were treated by generalized fever therapy and by a combination of fever therapy at 41.5° C and deep roentgen therapy.

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S. M. ATKINS, M.D.

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There is no essential difference in the roentgenologic technic of post-operative from pre-operative examination of the stomach, however, the barium meal should

APPARATUS

Tomography II (Theoretical Considerations) G Grossmann Fortschr a d Geb d Röntgenstrahlen, 1935, 51, 191-208

Geometric and physical deliberations of the various technical and practical tomographic propositions. This paper should be read in the original by those interested in the subject

H A JARRI, M D

CANCER (THERAPY)

Cancer of the Cheek (Buccal Mucosa) Study of 99 Cases with Results of Treatment at the End of Five Years Hayes I Martin and Otto H Pflueger Arch Surg, May, 1935 30, 731-747 (Reprinted by permission from British Med Jour, Sept 21, 1935, p 44 of Epitome of Current Medical Literature)

The authors review 99 cases of carcinoma of the cheek which occurred in the five year period from 1925 to 1929. The series included all cases, however advanced, in which there was histologic proof of the presence of cancer and the end results are based on the histories of patients observed for five years or longer.

Cancer of the cheek is chiefly a disease of old age, and is nine times as frequent among men as among women. The mid portion of the cheek opposite the occlusal level of the teeth, is the most common site although the disease may appear anywhere on the buccal mucosa or in either of the buccogingival grooves. Direct local extension of the primary growth into the adjacent soft parts may take place at an early stage of the disease and was seen in over 60 per cent of cases. Chronic irritation to the buccal mucosa by sharp or broken teeth, ill fitting dental appliances, syphilis and tobacco is the most obvious etiologic factor in carcinoma of the cheek. There was evidence of dental irritation in 23 cases. Leukoplakia was found in about 70 per cent of cases.

Cancer of the cheek is found to be epidermoid carcinoma in 95 per cent of cases. The disease is symptomless in the early stages and appears at first as a small ulcerated, indurated mass, which may or may not protrude above the surface of the mucosa. Unless the lesion begins in the center of the cheek the tendency is toward an early invasion of the upper or lower jaw, the lateral pharyngeal wall or the palate. As the tumor enlarges it becomes fissured and necrotic infection takes place, followed by swelling of the cheek and tenderness or pain. Metastasis usually to the submaxillary lymph nodes, occurs comparatively late in the course of the disease.

The most successful treatment was found to be a combination of irradiation and surgical intervention. Of the group under review 28 patients have been free from disease for from five to eight years.

The Relative Value of Surgery Radium and Roentgen Therapy in Carcinoma of the Breast Isaac Levin Am Jour Roentgenol and Rad Ther January 1935 33, 59-70

Surgery, radium and roentgen therapy are the only

methods in our possession for treating cancer of the breast. The modern methods of radical surgery in cancer of the breast represent a great advance over the old methods. However even with the latest methods of surgery not more than 10 per cent of all patients remain well five years after operation.

In view of the small percentage of the successful cases it is advisable not to differentiate so severely between radical and palliative surgery on the one hand when the indications for surgery and, on the other use less extensive methods of operating. Surgery should not be considered as the only therapeutic method, but rather as an indispensable adjuvant to radiotherapy. Electrosurgery may improve the surgical results.

Radiotherapy is the nearest to a specific remedy we possess in cancer and is from this standpoint superior to surgery and has a wider applicability. Limitations of radiotherapy are of such a nature as to be frequently overcome by a correct co-ordination with surgery.

S M ATKINS M D

CARBUNCLES

Roentgen Treatment of Carbuncles Whitmer B Frior Am Jour Roentgenol and Rad Ther January 1935, 33, 71-74

In the past three years the author has treated 56 carbuncles with x ray therapy and produced like many other roentgenologists, brilliant results. He deplors the surgeons and physicians failure to use this method of treatment more frequently and believes their apathy due to ignorance of it. Only one of these cases failed to respond and required surgical excision, which failed to save the patient.

Roentgen rays of 127-150 kv with 0 to 3 mm Al were employed depending on the depth of the lesion. From 200 to 250 r were applied as the initial dose and from 100 to 150 r in a day or two if proper reaction had not occurred.

The usual course of events were intensification of pain and elevation of temperature two to three hours after treatment followed by marked relief of pain within a few hours disappearance of induration and sharp localization of the lesion in from 24 to 48 hours drainage through a single opening and general subjective improvement. The acute inflammatory phase of the lesion usually subsided entirely in about two weeks and the resultant scar was very slight—some were completely aborted.

This treatment should be instituted as early as possible. In every case the patient is kept under surgical observation for other steps when necessary—usually only for very slight incision.

S M ATKINS M D

DIATHERMY

Deep Effect and Localization in the Short Wave Condenser Field F Nagelschmidt British Jour Radiol July 1935 8, 449-456 (Reprinted by per-

mission from British Med Jour Sept 21 1935, p 45 of Lpitome of Current Medical Literature)

Prominent difficulties in the technic of short wave therapy are according to this author, that the condenser field suffers deformation by the introduction of any object into the field between the two electrodes, the intense radiation which emanates in all directions from the electrodes, the wires, and the patient, and the absence of any practical measuring device. He believes that he has been able to overcome the first two of these sufficiently for practical purposes. He interposes suitably shaped auxiliary dielectric electrodes in order to concentrate the majority of the power of the whole field energy to a desired part of the portion of the body to be irradiated. Contact with the auxiliary electrodes (with or without a small air space between the metallic pole plates) and the dielectrics reduces considerably radiation losses by its damping effect. The size of the metallic pole plates can be relatively small. The dielectric employed (a glass tube containing white of egg) brings about an exact localization of the heating. When the size or form of the part to be irradiated is unsuitable the difficulty can be surmounted by the introduction of auxiliary electrodes of wax-paraffin mixtures or agar with certain admixtures.

DOSAGE

The Testing of the Calibration of Small Chamber Dosage Meters. G. Spiegler and K. Juris. *Strahlen therapie*, 1935, 54, 174-181.

The authors found that tests used so far for the calibration of small ionization chambers do not satisfactorily detect variations due to changes in atmospheric pressure and temperature. Errors in dosage may be as high as 10 per cent. They constructed, therefore, a new standard of comparison based on beta radiation of radium, which indicates changes proportional to fluctuation in pressure and temperature.

ERNST A. POHLE, M.D., Ph.D.

ENDOCRINE GLANDS

Roentgen Examination in Endocrine Pathology. J. Morelle and H. Solé. *Jour de Radiol et d'Electrol*, July, 1935, 19, 360-400. (Reprinted by permission from British Med Jour, Sept 21, 1935, p 45 of Epitome of Current Medical Literature.)

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There is no essential difference in the roentgenologic technic of post operative from pre-operative examination of the stomach; however, the barium meal should

be administered more slowly in order that adequate study of the mucosal pattern and operative stoma may not be obscured

When the first post operative study is made shortly after surgery has been performed the stomach is apt to be found atonic and containing more or less secretion in the region of the new stoma. There is apt to be more or less irregularity probably due to tissue swelling and the passage of the opaque material through the new opening is apt to be slower than will be observed later on. Even after many years the stoma does not tend to close except as the result of marginal ulcers or other diseases. On the other hand if the pylorus was blocked by sutures it will not remain closed but usually reopens within a few weeks.

The roentgenologic findings immediately and remotely following surgery are described for the various more common gastric operations including Billroth I, Billroth II, sleeve resection, local resection, total gastrectomy, pyloroplasty, gastroduodenostomy, enteroenterostomy, both in cases in which the desired results are obtained and in certain instances wherein complications and abnormal results follow.

Concerning obstruction occurring after operation the following causes may be the basis for the disturbed physiology: kinking of jejunal wall opposite stoma, prolapse of gastric mucosa into stoma, closure of the stoma, acute angulation at the duodenojejunal juncture, constriction of jejunum by contraction of opening in transverse mesocolon, volvulus of the efferent jejunal segment, hernia of the jejunum through the opening in the mesocolon, and intussusception of the jejunum into the stomach.

Errors in surgical technique have not been commonly encountered by the author. There is of course a fairly wide range in determining size and location of the stoma and length of the proximal jejunal segment which should be neither too short nor too long.

J. E. HANDE, M.D.

GENITO-URINARY TRACT (DIAGNOSIS)

Rupture of the Urinary Bladder. Louis Berger. *Am Jour Surg*, September, 1935, 29, 460-462.

The author reports a case of rupture of the bladder. From the history and findings of his case one is led to speculate as to the cause of the rupture. The question arises as to the possibility of an incomplete rupture occurring at the time of the injury, namely the leaving of all coats except the peritoneum which holds the bladder intact until at some future time coughing or over-distention may give rise to a tear in the peritoneum itself with subsequent complete rupture.

DAVIS H. PARDOLL, M.D.

GRENZ RAYS

Problems in Grenz ray Therapy. Friedrich Kalz. *Strahlentherapie* 1935, 54, 96-113.

The author undertook a very detailed study of the

skin reactions following exposure to Grenz rays under a large variety of conditions. He found that the reaction occurs in cycles as described before by Miescher for ordinary roentgen rays. Following doses of from 500 to 1500 r the erythema usually occurs in three cycles with the peak in the third cycle. Fractional application of the dose reduces intensity and duration of the skin reaction even after doses of from 600 to 1,000 r. Some cases show erythema with a bluish hue indicating a late injury of the blood vessels. Occasionally there occurs a so-called 'early erythema' which is quite different from the usual erythema. Hyperemia of the skin brings out the irradiated area even years after the exposure. The article is well illustrated.

FRANK A. POHLE, M.D., Ph.D.

HEART AND VASCULAR SYSTEM

The Clinical Value of Cardiac Measurements in Dorsocentral and Oblique Projections. J. G. Dillon and J. B. Gurewitsch. *Fortschr r d Geb d Röntgenstrahlen*, 1935, 51, 180-190.

A discussion of the various important methods of cardiac measurements advocating the procedure of Walter Gray (*Am Jour Roentgenol and Rad Ther* 1932, 27, 177, 555, 729) as it permits of estimation of the size of each ventricle.

H. A. JARRE, M.D.

THE KIDNEYS

Confusing Clinical Manifestations of Malignant Renal Neoplasms. C. D. Creevy. *Archiv Internal Med*, June 1935, 55, 895-916.

The first symptom of a malignant neoplasm of the kidney is often due not to the primary tumor itself but to a distant metastasis or to extension to a neighboring organ. Such a metastasis or extension may mimic a neoplasm of the bone, pulmonary disease, a lesion of the brain, spinal cord or peripheral nerves, cirrhosis of the liver, a lesion of the stomach or colon, or a tumor of the neck, or it may cause unexplained anemia, fever, or cutaneous lesions. It may also cause confusion with other diseases of the urinary tract or be masked by them. The primary tumor may be mistaken for an ovarian cyst. An additional case is reported in which the diagnosis was not made during life because of an associated undulant fever.

The lesions are best recognized in obscure cases by bearing in mind the possibility of a renal tumor, eliciting an accurate history and subjecting the patient to a careful physical examination, then excluding or ascertaining that diagnosis by intravenous urograms supplemented as is often necessary by retrograde pyelograms.

There was no instance in this group of solitary bony metastasis. Thirty-six different organs—counting bones as one organ system—were involved by metastasis in 92 cases of malignant renal neoplasms reviewed. Twelve different bones were affected.

E. M. SHEBESTA, M.D.

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